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Nuytsia

WESTERN AUSTRALIAN HERBARIUM

VOLUME 26 2015

WA BOTANIC GARDEN 50 2015 CELEBRATING 50 YEARS
BOTANIC GARDENS & PARKS AUTHORITY
THE GOVERNMENT OF WESTERN AUSTRALIA
Department of Parks and Wildlife

Volume 26 of *Nuytsia* commemorates the 50th anniversary of the establishment of the Western Australian Botanic Garden at Kings Park. To its many millions of visitors every year, this popular and important attraction provides a stunning insight into the spectacular flora of Western Australia, particularly in spring when the more than 3,000 native species on display are in full bloom (photograph by Kelly Shepherd, September 2015).

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A special issue commemorating the 50th anniversary of the
establishment of the
Western Australian Botanic Gardens at Kings Park

DEPARTMENT OF PARKS AND WILDLIFE
WESTERN AUSTRALIA

Nuytsia

Nuytsia is a peer-reviewed journal that publishes original papers and short communications on the systematics, taxonomy and nomenclature of Australian (particularly Western Australian) plants, algae and fungi.

Descriptions of taxa, revisions, identification guides, nomenclatural and taxonomic issues, systematic analyses and classifications, censuses, and information on invasive species are all considered.

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Preface to *Nuytsia* Volume 26, a special issue celebrating 50 years of the Western Australian Botanic Garden

This special issue of *Nuytsia* commemorates the 50th anniversary of the establishment of the Western Australian Botanic Garden at Kings Park, on the flanks of Mt Eliza in the heart of the city of Perth. To its many millions of visitors every year, this popular and important attraction provides a stunning introduction to, and insight into, the spectacular flora of Western Australia, particularly in spring when the more than 3,000 native species on display are in full bloom.

Many visitors, however, perhaps remain unaware of the important science – the exploration, discovery and taxonomy – that lies behind the floral displays showcased in the Garden. Visitors may also be surprised to learn that discovery of new species is a continual activity in Western Australia, boasting as we do one of the highest rates of discovery of new plant species anywhere on Earth. Discovery of new species, and its important corollary – the careful naming, painstaking description and authoritative documentation of the flora of Western Australia – is the context for this special issue.

Staff at Kings Park and Botanic Garden have for many years played an important role in taxonomic discovery in Western Australia. Former Directors such as John Beard and Stephen Hopper, and former Director of Science Kingsley Dixon, have both encouraged and been directly involved in survey, discovery, taxonomy and conservation of Western Australian plants. Many staff and students, both past and present, have travelled widely in the State, often for the purpose of collecting plants and seeds for the Garden, and in doing so have discovered new and noteworthy species.

This special issue, in which 50 new Western Australian species are named, represents an outstanding contribution by staff from Kings Park and Botanic Garden, particularly by the principal authors, Russell and Matthew Barrett. Crucial also have been the contributions of a wide range of co-authors, and of the dedicated technical and curatorial staff at Kings Park and the Western Australian Herbarium, without whom works such as these would be almost impossible.

Kings Park and the Western Australian Herbarium in many ways play complementary roles in understanding and conserving the flora of Western Australia. Much of the work of Kings Park is focused on the display, conservation and research of living plants and the State's Botanic Garden. The Herbarium has as its core Western Australia's State Collection of scientific specimens of plants, algae and fungi. This collection, and the expertise of the Herbarium's taxonomic and curatorial staff, provides the underlying basis for understanding Western Australia's rich flora, and are the key resources through which specimens of potential new species may be compared against existing taxa and understood in the context of a dynamically evolving taxonomic framework.

The long and fruitful collaboration between the Western Australian Herbarium and the Botanic Gardens and Parks Authority at Kings Park continues in this special issue of *Nuytsia*. So to, through the papers herein, does the important task of documenting and naming the globally important flora of Western Australia.

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Many new, remarkable and exciting species have been discovered in the last 50 years; many more will be discovered in the next 50 years. These contributions are a step along the way of a large and important task, one that requires collaborations such as this, and the dedication of large numbers of people, to ensure that the wonderful flora with which we share our State can be better understood, and hence better conserved for future generations.

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Nuytsia The journal of the Western Australian Herbarium

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Fifty new species of vascular plants from Western Australia—celebrating fifty years of the Western Australian Botanic Garden at Kings Park

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Abstract

Barrett, R.L. Fifty new species of vascular plants from Western Australia—celebrating fifty years of the Western Australian Botanic Garden at Kings Park. *Nuytsia* 26: 3–20 (2015). This paper introduces a special issue of *Nuytsia* containing seven collaborative papers naming 50 new species of Western Australian vascular plants. It has been compiled to celebrate the 50th anniversary of the opening of the Western Australian Botanic Garden at Kings Park. Several species are named after former Kings Park staff to honour their contributions to botany in Western Australia, including one that occurs naturally in the Kings Park bushland and is named after one of the designers of the Botanic Garden. Field research by Kings Park staff across Western Australia, including the rediscovery of *Auranticarpa resinosa* (Domin) L.W.Cayzer, Crisp & I.Telford, missing for 180 years, is documented.

Introduction

The Western Australian Botanic Garden at Kings Park was officially opened in October 1965 (Figure 1) and celebrates its 50th anniversary in 2015 (Webb 2013). To commemorate the work of staff, students and volunteers in the discovery and promotion of the Western Australian flora, the Botanic Gardens and Parks Authority (BGPA), the management authority for Kings Park and Botanic Garden, commissioned a special project to name 50 new plant species discovered or studied by BGPA staff. Each of these species is formally named and described in a series of taxonomic papers. Forty-one of the species are only known from few locations and are conservation-listed in Western Australia.

The species named in this series of papers have been collected and recognised over a period of decades, based on hundreds of field trips made by staff and students based at Kings Park, often to remote parts of Western Australia. While a large proportion of the species named here were discovered in the remote Kimberley region, *Calectasia elegans* R.L.Barrett and *Lepidosperma oldhamii* R.L.Barrett both occur in the Perth area, the latter in Kings Park bushland (Barrett & Barrett 2015a). Many of the new species have been collected as part of collaborative studies with a wide range of individuals and

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organisations, and this work is summarised. Former Kings Park staff and one of the designers of the Botanic Garden are honoured with new species named after them: *Aphyllodium beardii* R.L.Barrett (for John Beard), *Calectasia demarzii* R.L.Barrett (for Herbert Demarz), *Hybanthus bennettiae* R.L.Barrett (for Eleanor Bennett), *Lepidosperma fairallianum* R.L.Barrett (for Arthur and Pauline Fairall), *L. hopperi* R.L.Barrett (for Stephen Hopper) and *L. oldhamii* R.L.Barrett (for John Oldham) (Barrett & Barrett 2015a).

Kings Park was first set aside as public land in the early 1830s and with its central and prominent location in the City of Perth, is a special place for local residents and visitors alike. While the City has changed considerably in the time since the Botanic Garden was established, its significance, for both the location and the work conducted by staff, has not. Since its inception, the main focus of the Botanic Garden has been the discovery, promotion and conservation of the Western Australian flora (Figures 2, 3), with many staff contributing to these efforts over the last 50 years. Staff, students and volunteers at Kings Park have made many internationally significant contributions to scientific research, along with many visiting researchers who have conducted studies within the Kings Park bushland. Maps of collections made by the most prolific collectors during their time at Kings Park are shown in Figures 4 and 5, based on data compiled from the database of Australia's Virtual Herbarium.

Figure 1. Director of Kings Park John Beard with Premier David Brand and Mrs Brand at the opening of the Western Australian Botanic Garden in 1965. Photograph from BGPA Archive.

Figure 2. Ernst Wittwer preparing the wildflower display in 1965 for the opening of the Western Australian Botanic Garden. Photograph from BGPA Archive.

Figure 3. Elaborate displays of wildflowers cultivated in the Kings Park Nursery have always featured prominently at the Kings Park Wildflower exhibitions and festivals, as seen here in 1971. Photograph from BGPA Archive.

Kings Park and Botanic Garden history

Mt Eliza, around which Kings Park is centred, has a very significant place in local Nyoongar history, being known by a number of names, including *Karta Koomba* (the big hill), *Karra katta* (the hill of the spiders), *Yongariny* (place for catching kangaroo), *Geenunginy Bo* (the place for looking a long way) and *Karlkarniny* (place for sitting by the fire), each with its own cultural context (Collard & Harben 2010). Kings Park also has a relatively long European history, with the land around Mt Eliza being set aside for 'public purposes' by Lieutenant Governor James Stirling and Surveyor-General John Septimus Roe in the 1830s, then gazetted as a public reserve by Surveyor-General Malcolm Fraser in 1871, and expanded to near its current size by Surveyor-General John Forrest in 1890 (Erickson 2009).

One of the earliest botanical collections made in Western Australia was probably made near or in Kings Park by the expedition led by Willem de Vlamingh in 1697 (Hamilton & Bruce 1998). The unusual (to European eyes) vegetative morphology of the sterile specimen led to it being described as a fern, *Polypodium spinulosum* Burm.f., some 70 years later (Burman 1768). The specimen is actually a member of the Proteaceae family, *Synaphea spinulosa* (Burm.f.) Merr. Important early botanical collections in and around Kings Park itself were made by Charles Frazer (1827), James Mangles (1931), Baron Karl von Hügel (1833), J.A. Ludwig Preiss (1838–1842), Alexander Morrison (1897–1906), Jeremiah Sheath (Superintendent, 1904–1915) and Carl E.H. Ostenfeld (Ostenfeld 1916, 1918).

The Kings Park bushland, located at the edge of a major regional biodiversity hotspot (Hopper & Gioia 2004), has a large number of native plant species (351 recorded to date; Barrett & Pin Tay 2005; R.L. Barrett, unpubl. data). A number of species have been named from specimens collected in or near Kings Park, including the fungus *Amanita ochroterrea* Gentilli ex Bas. (Gentilli 1953; Davison 2011) and the plants *Acacia benthamii* Meisn., *Candollea parviflora* Steud. (=*Hibbertia racemosa* (Endl.) Gilg), *Casuarina preissiana* Miq. (=*Allocasuarina humilis* (Otto & F.Dietr.) L.A.S.Johnson), *Cryptandra tridentata* Steud. var. *tomentosa* Reissek (=*Stenanthemum notiale* Rye subsp. *chamelum* Rye), *Dodonaea hackettiana* W.Fitzg., *Drosera porrecta* Lehm., *Eurybia axillaris* DC. var. *exaltata* Steetz (=*Olearia axillaris* (DC.) Benth.), *Gnephosis angianthoides* (Steetz) Anderb., *Grevillea preissii* Meisn., *Helipterum roseum* var. *nigropapposum* Ostenf. (=*Rhodanthe chlorocephala* (Turcz.) Paul G.Wilson subsp. *rosea* (Hook.) Paul G.Wilson), *Machaerina preissii* (Nees) L.A.S.Johnson & Koyama, *Orthrosanthus laxus* (Endl.) Benth., *Patersonia turfosa* Endl. (=*P. occidentalis* R.Br.), *Pomaderris albicans* Steud. (=*Spyridium globulosum* (Labill.) Benth.), *Scaevola holosericea* de Vriese (=*S. anchusifolia* Benth.), *Simsia latifolia* R.Br. var. *gracilis* Ostenf. (=*Stirlingia latifolia* (R.Br.) Steud.), *Tetraria octandra* (Nees) Kük. (Bennett 1992, 1995; Barrett & Pin Tay 2005), *Calectasia narragara* R.L.Barrett & K.W.Dixon (Barrett & Dixon 2001), *Poranthera moorokatta* R.L.Barrett (Barrett 2012a) and *Lepidosperma oldhamii* R.L.Barrett (Barrett & Barrett 2015a). Several plant species are conservation-listed, being restricted to the Perth area, with their main populations occurring in Kings Park (*Acacia benthamii*, *Dodonaea hackettiana*, *Jacksonia sericea* Benth. and *Poranthera moorokatta*) (Barrett 2012a; Barrett & Pin Tay 2005). Development pressures on Kings Park were one of the reasons for the founding of the Western Australian Naturalists Club, to give a combined voice to concerns over threats to native vegetation (Main *et al.* 1957).

A general history of exploration activities by staff at Kings Park has been provided by Erickson (2009). Most of the voucher specimens for botanical collections made by staff at Kings Park are held at the Western Australian Herbarium (PERTH; Department of Parks and Wildlife). A working collection is held in the Kings Park Research Herbarium (KPBG), and not all specimens are duplicated at PERTH. Significant collections in KPBG's BG-Base database (10,347 plus many more collections yet to be incorporated) include L. Sweedman (4,475 collections), H. Demarz (802 collections), J. Beard (585

collections), G. Keighery (521 collections), F. Lullfitz (374 collections), A. Fairall (348 collections), E. Wittwer (320 collections) and J. Blockley (92 collections).

Fifty new species from Western Australia

In January 2014, a call by the BGPA for special projects to celebrate the 50th anniversary of the Western Australian Botanic Garden at Kings Park was made and a proposal to name 50 new species of Western Australian plants accepted. Many currently undescribed plant species have been discovered by Kings Park staff in the field, through studies in herbaria, or through phylogenetic studies. The 50 species named in this series of papers were selected to represent the diverse range of plant groups and geographic distribution that staff have worked with and in over the past 50 years. They are named in this special issue in collaboration with other authors from around Australia. An additional five new species described as part of this project are named in associated papers published elsewhere (Barrett 2015; Barrett & Barrett 2015b).

Thirty-eight of the new species were discovered during long-running surveys in the Kimberley region of Western Australia (Figure 4) and some specific background to discovery in the region is presented here. A former Director of Kings Park, John Beard, travelled widely in the Kimberley during his vegetation mapping project and made many valuable collections (Beard 1990). He was the first to formally recognise the presence of extensive vine thickets in the region, despite most scientists considering it too dry for such vegetation (Beard 1976; Beard & Clayton-Greene 1984; Beard *et al.*

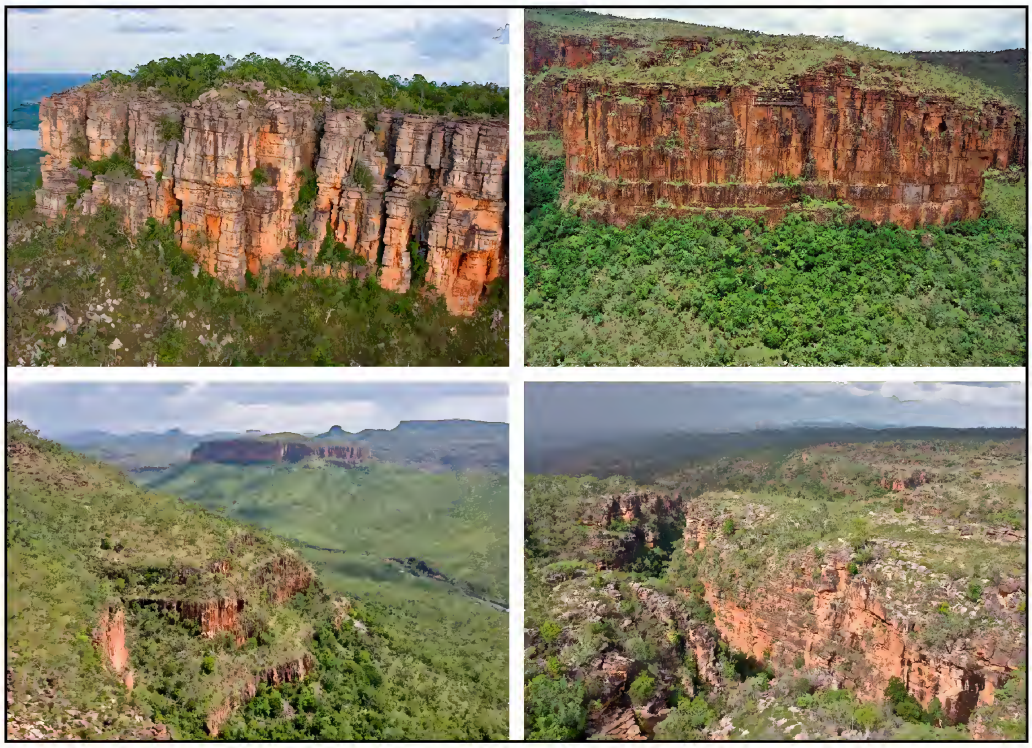

Figure 4. Rugged, highly dissected sandstone plateaux in the Prince Regent River area. These isolated areas have been found to be habitat for numerous locally endemic plant species. Photographs by R.L. Barrett.

1984). The discovery of this vegetation by Beard, as well as collections of orchids and interesting geophytes by Joe Smith (a grader driver with AMAX Exploration on the Mitchell Plateau), spurred further interest in the region (Dixon *et al.* 1989). Kingsley Dixon, a former Science Director at Kings Park, subsequently made his first trip to the Mitchell Plateau in 1980 to study geophytes (Pate & Dixon 1982; Brown *et al.* 2008). He made several trips to the region, and in the early 1990s was joined by botanical artist Pat Dundas who was working with Andrew Brown, Dixon and Stephen Hopper on a book on the orchids of Western Australia (Brown *et al.* 2008).

Kevin Kenneally, a Senior Research Scientist with the then Western Australian Department of Conservation and Land Management, had worked on the flora of the Kimberley region since the mid-1970s. He collaborated with Beard on studies of vine thickets in the Kimberley while conducting flora surveys (Beard *et al.* 1984; Beard & Kenneally 1987; Kenneally 1989). I first met Kenneally at a Gould League camp in Perth while I was in primary school and living on Beverley Springs Station (now known as Charnley River Station and Artesian Range Sanctuary) in the north-west Kimberley. I began collecting specimens and bringing them to Kenneally and became a volunteer at the Western Australian Herbarium in 1991 while studying at boarding school in Perth. Kenneally also introduced me to carnivorous plant and triggerplant enthusiast Allen Lowrie in 1992 and a long-term collaborative study of these groups in the Kimberley began (Barrett 1994; Barrett & Lowrie 2013; Lowrie 2014; Barrett *et al.* 2015). I was soon joined by my elder brother Matt in collecting plants and bringing the collections to the Western Australian Herbarium.

Our association with the Herbarium has been pivotal to our research on the flora of Western Australia and the Kimberley in particular. Building on the first *Flora of the Kimberley region* (Wheeler 1992), a new set of identification keys to the Kimberley flora has been prepared, now covering around 3,500 plant taxa. This has only been possible through extensive collaborations with staff at the Herbarium, and taxonomists around Australia, to build our knowledge of the entire flora. The processing and incorporation of over 12,000 voucher specimens that underpins this work has been a major undertaking for Herbarium staff and volunteers. Incorporation of these specimens has been critical for the addition of new phrase names to the Western Australian plant census, and for the review of conservation status for a large number of Kimberley plant taxa. Collaborative work with the Herbarium has been very rewarding for all concerned, as evidenced by the number of new species that have been added to the plant census, and new species described based on our collections.

Some of our earliest collections were of species that were soon to be described as new, including *Stylidium costulatum* Lowrie & Kenneally, *S. adenophorum* Lowrie & Kenneally, *S. barrettorum* Lowrie & Kenneally, *S. fimbriatum* Lowrie & Kenneally and *S. diceratum* Lowrie & Kenneally (Kenneally & Lowrie 1994; Lowrie & Kenneally 1996, 1997, 1998) and *Byblis rorida* Lowrie & Conran (Lowrie & Conran 1998). The first species we described, in collaboration with Alistair Hay from the Royal Botanic Gardens, Sydney, was *Typhonium peltandroides* A.Hay, M.D.Barrett & R.L.Barrett (Hay *et al.* 1999). This species was found in a single gorge in the centre of Beverley Springs (Charnley River) Station; only recently has a second population been discovered, in Prince Regent National Park (R.L. Barrett *et al.*, unpubl. data; Figure 5). Less than 200 individuals have been found.

In 1993, Pat Dundas' daughter met Alison Barrett, sister of Matt and Russell Barrett, at boarding school and learnt of the family's interest in the Kimberley region's plants. Dundas mentioned this to Dixon, who contacted the Barrett family and arranged a wet season field trip to the station to look for orchids (Figure 6). Thus began a long association between the Barrett brothers and Kings Park. It was also the first of three field trips conducted while the Barrett brothers lived on Beverley Springs (Charnley River) Station, and several new species of orchid were discovered, along with the first

Figure 5. *Typhonium peltandroides*, the first species named by the Barrett brothers, with Alistair Hay. Photographed in Prince Regent National Park, January 2010. Photographs by R.L. Barrett.

Figure 6. A – Kingsley Dixon, Lionel Johnson, Pat Dundas and Matt Barrett on an expedition searching for orchids in the Edkins Range, north-west Kimberley in 1994; B – *Calochilus holtzei*, one of three sexually deceptive beard orchids found in the Kimberley region. Photographs by R.L. Barrett.

record of *Liparis habenarina* (F.Muell.) Benth. for Western Australia. Following his completion of an Engineering/Science (Chemistry) double degree at the University of Western Australia (UWA), Matt Barrett took a short-term contract at Kings Park in 1997. I started working at Kings Park as a Research Assistant to Dixon in late 1998 while completing a Science degree (Botany and Geography) at UWA. Matt Barrett went on to complete a PhD on the genetics of the *Chamelaucium uncinatum* Schauer species complex (Barrett 2006) while I went on to complete a PhD on the systematics and ecology of *Lepidosperma* Labill. and allied sedge genera (Barrett 2012b).

Since then, field trips to the Kimberley region have continued on a regular basis, with a survey conducted for the Australian Heritage Commission on the Yampi Peninsula in 2001 (Barrett *et al.* 2001; Start *et al.* 2001). During the time the Barrett brothers lived on Beverley Springs (Charnley River) Station (1981–1996) a rough track existed that went to the southern border of Prince Regent Nature Reserve (now National Park) and a specific interest in this area developed. The Prince Regent River area, one of the highest rainfall zones in the Kimberley (>1,200 mm *per annum*), comprises a very dissected sandstone plateau matrix with relatively high summits (many peaks and plateaux >600 m high); it has proven to be very rich in plant diversity, with many new species discovered there. Fieldwork has concentrated on the rugged sandstone ranges and plateau tops. Deep gorges provide habitat for monsoon rainforests that are now being found to contain relictual species (Harrington *et al.* 2012; Köhler & Shea 2012).

A major rediscovery was made by me and Maurice O'Connor on a Kings Park expedition in January 2001, with the location of a single juvenile plant of *Auranticarpa resinosa* (Domin) L.W.Cayzer, Crisp & I.Telford (formerly *Pittosporum resinosum* Domin) near the headwaters of the Prince Regent River. This species had only been known from a single fruiting collection made by Allan Cunningham on the Philip Parker King expedition to map the Australian coastline in 1820 (Cayzer *et al.* 2000). The collection location, on the Hunter River in the north-west Kimberley, had at times been suggested to be an error for the Hunter River in Queensland, and the Kimberley distribution was considered doubtful as efforts to relocate the species along the Hunter River in the Kimberley had proved unsuccessful (K.F. Kenneally pers. comm.).

The initial discovery, of a juvenile plant with *Grevillea*-like leaves and a citronella-like scent, could not be matched with certainty to *Auranticarpa resinosa*, as juvenile leaves of the species were unknown, though their similarity to juvenile leaves of *A. ilicifolia* L.W.Cayzer, Crisp & I.Telford made it highly likely. Fortunately, adult and juvenile plants were located by me and Matt Barrett at a separate location a few days later on top of an isolated sandstone massif, though no flowers or fruit could be found at that time. Fruit was finally recollected in 2003, along with young buds, although the flowers of this species remained unknown. While additional populations were discovered in 2007 and 2008, flowering material was not collected until 2010, 190 years after the species was first discovered, when three plants were found with open flowers that were cream and very sweetly scented (Figure 7).

Around fifteen populations of this species have been discovered since 2001, all in the general vicinity of the Prince Regent River, north to near the Roe River. However, most populations are very small and fewer than 100 individuals are known, most too young to be fertile. *Auranticarpa resinosa* appears to be highly fire sensitive, with stems often killed by fire, though we have observed resprouting from lignotubers following 'cool' fires. It is likely that the original populations on the Hunter River seen by Cunningham have been burnt out and the species is now restricted to very dissected sandstone outcrops that naturally exclude or reduce the intensity of fire. An alternative possibility is that Cunningham did make an error in his collecting locality, as his diary for the expedition records the collection of a fruiting *Pittosporum* Gaertn. from the mainland adjacent to St Andrews Island (Curry *et al.* 2001),

Figure 7. *Auranticarpa resinosa*. A – seedling; B – Matt Barrett with adult tree; C – Russell Barrett with flowering branch; D – flowers; E – fruit. Photographs by R.L. Barrett (A, B, D, E); M.D. Barrett (C).

not far from known modern collections. The only other *Pittosporum* species known for the immediate area is *P. spinescens* (F.Muell.) L.W.Cayzer, Crisp & I.Telford, which was at that time unnamed and, until recently, classified in the genus *Citriobatus* A.Cunn. ex Louden.

The genus *Salomonia* Lour. (Polygalaceae) was first collected in Western Australia by me and Matt Barrett on one of our earlier collecting trips to Bachsten Creek at the southern edge of Prince Regent National Park in December 1992, through the collection of *S. ciliata* (L.) DC. (Kenneally 1995). More recent discoveries in the area include the location of the coastal rein orchid, *Habenaria hymenophylla* Schltr., where a small population was located under a dense forest of native nutmeg (*Myristica insipida* R.Br.) in a deep side arm of Pitta Gorge in January 2010 by me, Peter Kendrick and Graeme Sparkes (Brown *et al.* 2013). The nearest known population is near Darwin, some 1,200 km to the north-east. Our observations of Kimberley orchids contributed significantly to the tropical orchid sections of Brown *et al.* (2008, 2013).

An even more remarkable discovery was the Kimberley Lemon Myrtle, *Backhousia gundarara* M.D.Barrett, Craven & R.L.Barrett, first discovered by Dave Dureau and Wayne O'Sullivan, members of the Broome Botanical Society, who were hiking in a remote part of the Prince Regent River area in

2001. They recognised that the tree was unusual, resembling a guava, with smooth bark and opposite leaves, but finding only a few old flowers the identity of the tree was uncertain. In 2003, Queensland botanists Gary and Nada Sankowsky found a second population of the same species near the first site and immediately recognised it as a species of *Backhousia* Hook & Harv. Matt Barrett and I revisited the site several times, eventually collecting fertile material in March 2010 on an expedition funded by BGPA (Harrington *et al.* 2012; Figure 8). The nearest other species of lemon myrtle is in north Queensland; *B. gundarara* may be a relictual species that has survived in fire-protected vine thickets in rugged Kimberley landscapes. The expected imminent arrival of myrtle rust (*Puccinia psidii* G.Winter) in the Kimberley may put this species at risk.

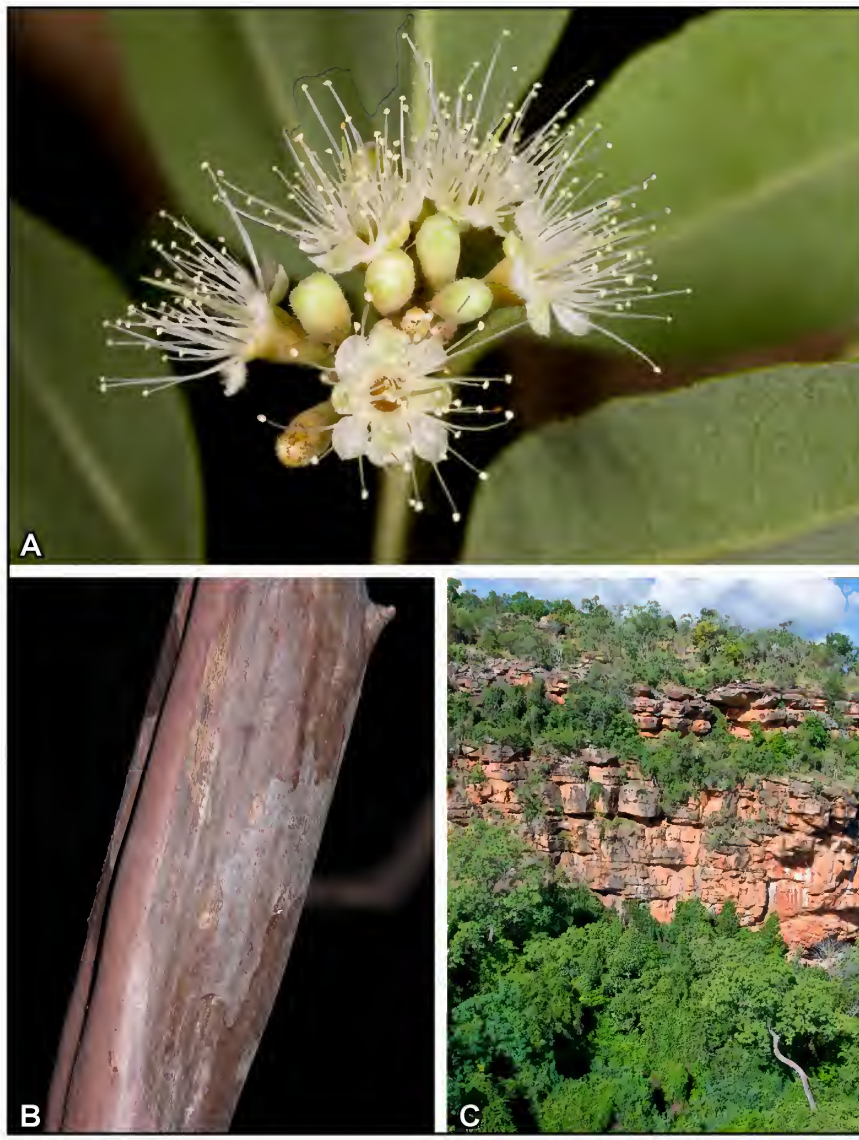

Figure 8. The rare Kimberley Lemon Myrtle, *Backhousia gundarara*, is only known from two locations in the upper Prince Regent River area growing at the base of large cliffs. A – flowers; B – guava-like bark; C – habitat. Photographs by R.L. Barrett.

These species occur in vine thickets, at the base of tall, sandstone cliffs below extensive sandstone plateaux. This set of environmental features provides a relatively stable environment with a higher degree of resilience to climatic fluctuations than many of the surrounding habitats, due to the accumulation of water within the sandstone matrix of the plateau during the wet season, which is then able to feed through rock fissures and supply water as small springs and seepage to the base of the cliffs. This constant water supply provides a unique protected environment during the long dry seasons naturally experienced across the Kimberley region. As much of the rainfall runs off the landscape as surface flows, the amount of water that soaks into the sandstone matrix is probably not significantly reduced during periods of low wet season rainfall, thus creating a climatic refugium at the base of such cliffs.

Access to remote areas of the Kimberley is often difficult, especially during the wet season, which is the best time of year to collect fertile plant material. For much of the region, where there are no roads, access can only be gained by helicopter, at times by quad bike, or on foot across rugged terrain (Figure 9). Access to these areas is the first of a number of challenges, with the collection of specimens an equally challenging task; plants are often located on cliff faces, or flowers and fruit high in tree-tops. It is then difficult to dry the collections before they get mouldy in very humid conditions, often without access to power (Figure 10). But visiting the region in the wet season is botanically rewarding.

Figure 9. Access to many remote areas of the Kimberley region requires a helicopter, quad bikes or walking. A – Prince Regent National Park; B – Lawley River National Park; C – quad bike loaded with specimens, Doongan Station; D – Peter Kendrick and Michi Maier exploring the remote Prince Regent National Park on foot. Photographs by R.L. Barrett.

Figure 10. Plant collecting in the Kimberley has many challenges including collecting plants in remote locations, working in humid conditions and drying plants without power. Photographs by M. Maier (A); R.L. Barrett (B).

In particular, cliff faces are important places to collect plants, with several new species apparently restricted to these habitats having been discovered in recent years.

The richest areas for new species discovery have been sandstone pavements. These environments are very highly seasonal, with thin sandy soils and shallow, ephemeral rock pools providing distinct habitats for many annual species and hardy perennials such as the resurrection grasses (genus *Micraira* F.Muell.) and woody shrubs such as *Calytrix gomphrenoides* M.D.Barrett & Craven (Barrett *et al.* 2009b) (Figure 11). While most of these habitats occur in the higher rainfall zone of the north-west Kimberley, a number of locally endemic species are also found on sandstone and limestone habitats in the south-east Kimberley (Figure 12). Aquatic environments, although usually highly ephemeral in the Kimberley, include a number of distinctive and endemic species, including *Myriophyllum callitrichoides* subsp. *striatum* Orchard and the highly reduced *Nymphaea ondinea* Löhne, Wiersema & Borsch (previously *Ondinea purpurea* Hartog; Figure 13). Saline aquatic environments are also plentiful and diverse along the complex Kimberley coastline, with one of the highest diversities of mangrove species in the world (Duke 2006).

Another area of the Kimberley where we have made extensive collections includes Doongan and Theda Stations in the North Kimberley, and the adjacent Drysdale River National Park. A large number of new species have been discovered on these stations, particularly on sandstone pavements at Theda Station, with ten species from this area described in this special issue. Two wattle species collected around Theda Station have already been named, as *Acacia anastomosa* Maslin, M.D.Barrett & R.L.Barrett and *A. perpusilla* Maslin, M.D.Barrett & R.L.Barrett (Maslin *et al.* 2013). *Solanum zoeae* R.L.Barrett was named from a single location on Doongan Station (Barrett 2013). A smut fungus, *Tilletia micrairae* R.G.Shivas, M.D.Barrett, R.L.Barrett & McTaggart, the only species known from the unusual resurrection grass genus *Micraira*, has also been named, known from just two populations on Theda Station (Barrett *et al.* 2009a).

Understanding the biological diversity of the Kimberley region is critical to long-term management of the region. In such a large, sparsely populated region, landscape management has many challenges,

Figure 11. A, B – sandstone pavements, with shallow soils that only briefly support plants during the wet season, have been rich areas for the discovery of new species; C – *Calytrix gomphrenoides* is only known from the vicinity of the Prince Regent River; D – *Drosera caduca* is the only carnivorous plant known to spend most of its life cycle in a non-carnivorous state, possessing insect-traps only on its first few, juvenile leaves. Photographs by R.L. Barrett.

the primary one being fire. Around a third of the Kimberley region is burnt every year and much is burnt every three years, a rate that is detrimental to many fire-sensitive species (Vigilante & Bowman 2004). The effects of frequent fire are particularly evident in the pindan, the dominant vegetation of the Dampierland bioregion, where the majority of species are either killed by fire or resprout from ground level, causing a very dramatic reduction in biomass and cover (Figure 14).

It is critical for conservation and the development of appropriate management strategies that we understand what species exist, where they occur and their ecological requirements for survival. The 50 species named in this special issue also draw attention to the fact that several hundred additional species are known from the Kimberley that remain unnamed, and little is known of their ecology. Many of the species described in this special issue are locally restricted in distribution and may be rare or threatened. Formal scientific description of these species is the first step to ensuring their conservation. It is hoped that presenting these species descriptions in a special issue will promote further research on the systematics, ecology and conservation of the Western Australian flora.

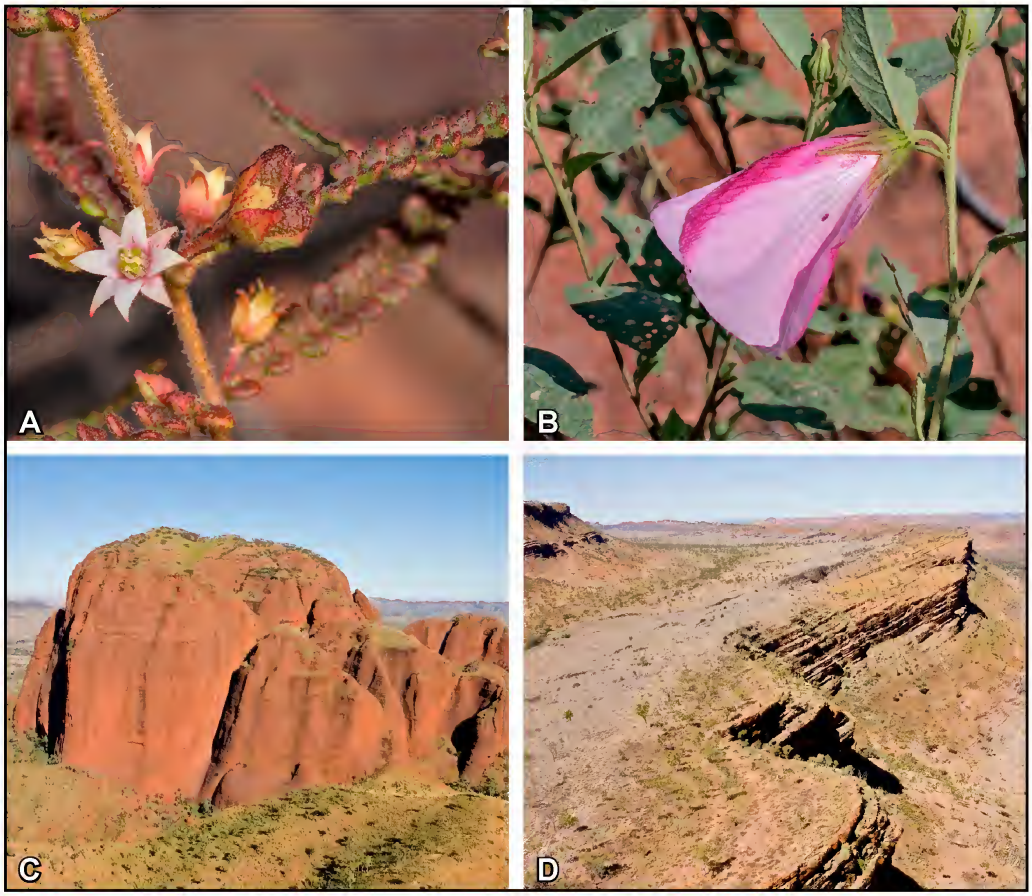

Figure 12. A number of localised species can be found in the semi-arid south-east Kimberley. A – *Boronia minutipinna*; B – *Hibiscus squarrulosus*; C –sandstone hill south-west of Kununurra, habitat for *Lindernia cleistandra*; D – limestone ridge near the Parker Range where a new species of *Triodia* was discovered. Photographs by R.L. Barrett.

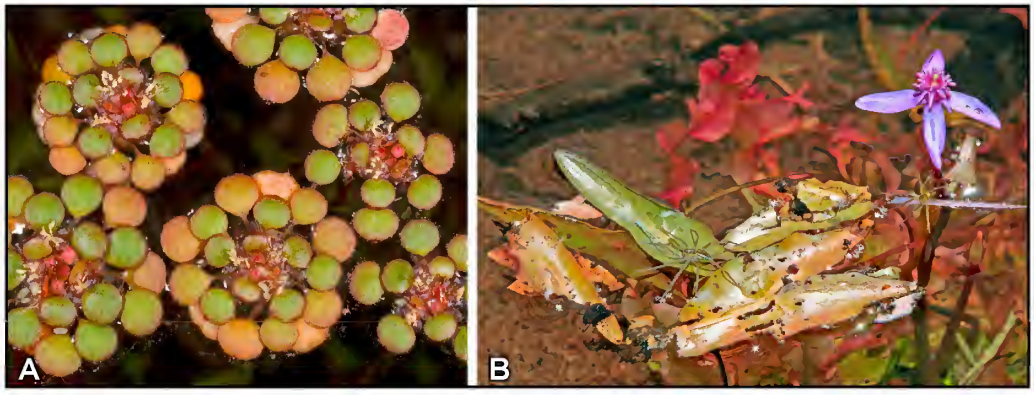

Figure 13. Several unusual aquatic plants are endemic to the Kimberley region. A – floating leaves and flowers of *Myriophyllum callitrichoides* subsp. *striatum*; B – *Nymphaea ondinea* (previously *Ondinea purpurea*), an odd water lily with the petals usually reduced to staminodes. Photographs by R.L. Barrett.

Figure 14. Around a third of the Kimberley landscape is burnt every year. This high fire frequency is highly detrimental for many ecosystems and fire sensitive species of plants and animals. The effects of fire can be clearly seen in the Pindan, where dense *Acacia* thicket is being rapidly replaced with open, annual grasslands and sparse shrubs. Photograph by R.L. Barrett.

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Twenty-seven new species of vascular plants from Western Australia

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Abstract

Barrett, R.L. & Barrett, M.D. Twenty-seven new species of vascular plants from Western Australia. *Nuytsia* 26: 21–87 (2015). Twenty-seven new species are described from Western Australia. *Bossiaea arenitensis* R.L.Barrett, *B. zarae* R.L.Barrett (Fabaceae), *Commelina roensis* M.D.Barrett & R.L.Barrett (Commelinaceae), *Crinum joesmithii* M.D.Barrett & R.L.Barrett (Amaryllidaceae), *Eriocaulon rivicola* G.J.Leach, M.D.Barrett & R.L.Barrett (Eriocaulaceae), *Glycine remota* M.D.Barrett & R.L.Barrett (Fabaceae), *Hybanthus bennettiae* R.L.Barrett (Violaceae), *Mitrasacme thedae* M.D.Barrett & R.L.Barrett (Loganiaceae), *Nymphoides astoniae* M.D.Barrett & R.L.Barrett (Menyanthaceae), *Proiphys kimberleyensis* M.D.Barrett & R.L.Barrett (Amaryllidaceae), *Schoenus thedae* M.D.Barrett & R.L.Barrett (Cyperaceae), *Trachymene pavimentum* M.D.Barrett & R.L.Barrett (Araliaceae), *Tribulopis marliesiae* R.L.Barrett (Zygophyllaceae), *Triodia celsa* M.D.Barrett and *T. diantha* M.D.Barrett (Poaceae) are described from the Kimberley region. *Aphyllodium beardii* R.L.Barrett (Fabaceae) is described from the Great Sandy Desert and *Triodia basitricha* M.D.Barrett is described from the Pilbara region. *Calectasia demarzii* R.L.Barrett, *C. elegans* R.L.Barrett, *C. jubilaea* R.L.Barrett, *C. valida* R.L.Barrett (Dasypogonaceae), *Caustis deserti* R.L.Barrett, *C. gigas* Meney & K.W.Dixon ex R.L.Barrett, *Lepidosperma fairallianum* R.L.Barrett, *L. hopperi* R.L.Barrett, *L. oldhamii* R.L.Barrett (Cyperaceae) and *Poranthera asybosca* R.L.Barrett (Phyllanthaceae) are described from the south-west of Western Australia. All new species are illustrated and their conservation status assessed.

Introduction

This paper formally names and describes a miscellany of twenty-seven new species of Western Australian vascular plants. About a third of these are apparently restricted to microhabitats (0.5–2,000 m across) associated with sandstone lithologies in the Kimberley region, including skeletal sand over sheeting sandstone pavements, cliff faces, shallow rock holes, and rock overhangs. The skeletal soils and resulting short growth season in these microhabitats means that they are dominated by annuals or perennating perennials, except for the cliff faces which are dominated by perennials, presumably because their roots can penetrate further into deep water reserves through fractures. Such microhabitats are also often naturally protected from fire and potentially provide a refuge for species requiring longer fire intervals than those experienced in the surrounding savannahs.

http://florabase.dpaw.wa.gov.au/nuytsia/
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Due to the shallow soils, these sites dry out rapidly at the end of the wet season (usually in April) and consequently have been only incidentally surveyed by most previous collectors and often missed in targeted surveys, which for logistical reasons are typically carried out in the early dry season. In association with other survey team members (as detailed in the collection citations) we have targeted these sites across the Kimberley (see Barrett 2015), resulting in the discovery of many new taxa, most of which are apparently very restricted in population extent or species range. Twenty-one (78%) of the taxa described herein are listed as being of conservation concern, all of which require additional surveys to better understand their distribution and rarity. Given that many such isolated microhabitats in the Kimberley region have not yet been surveyed, many localised or rare species probably remain to be discovered and we suggest that these are the most restricted species that therefore may have the highest conservation significance.

Other species described in this paper come from across Western Australia. Some have long been recognised as distinct taxa and listed on *FloraBase* (Western Australian Herbarium 1998–) under phrase names (e.g. *Caustis* sp. Gigas (A.S. George 9318)) while others have only recently been recognised (e.g. *Poranthera asybosca* R.L.Barrett). *Aphyllodium beardii* R.L.Barrett and *Triodia basitricha* M.D.Barrett are described from remote parts of the arid zone, while *Lepidosperma oldhamii* R.L.Barrett is described from Kings Park in the centre of Perth. These species illustrate the point that there are many species throughout Western Australia that still require formal description. Indeed, there are almost 1,450 informal taxa currently listed on *FloraBase* (Western Australian Herbarium 1998–).

Methods

The full range of variation in available specimens is given in the descriptions, but measurements outside the observed range can be expected given the limited range of available material. Most descriptions are based on herbarium specimens, though in some cases fresh material from the field or cultivation, or material preserved in 70% ethanol, was also utilised. Scanning Electron Microscope (SEM) images were produced from dry material gold-coated using an EMITECH K550X Sputter Coater and imaged at 15 KVa using a Jeol JCM 6000 NeoScope bench-top SEM.

Taxonomy

Amaryllidaceae

Crinum joesmithii M.D.Barrett & R.L.Barrett, *sp. nov.*

Type: cultivated: Kings Park and Botanic Garden [from a bulb collected in the Edkins Range], Western Australia [precise locality withheld for conservation reasons], 31 January 2014, *R.L. Barrett* RLB 8344 (*holo*: PERTH 08614466; *iso*: CANB, DNA, PERTH 08615004).

Crinum sp. West Kimberley (J.A. Smith s.n. 7/1/1979), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Glabrous geophytic *perennial*, with a bulb that is often extended as a neck to ground level. *Leaves* 6–8, basal, sessile, deciduous, erect, 340–690 mm long, 5.1–11.7 mm wide, dull green to slightly glaucous, with parallel venation, not obviously keeled, with a lunate (U-shaped) channel 5.5–10.7 mm deep; base up to 20 mm wide where flaring, thickly spongy-succulent; margin sparsely but distinctly tuberculate along most of length; apex acute. *Inflorescence* a scapose umbel with 2(–6) flowers in a

single 'whorl'; scape arising adjacent to leaves coincident with leaf development; peduncle 15–55 cm long above soil, 13 mm wide × 8–9 mm thick at base, 9.0–10.5 mm wide × 7–8 mm thick at middle, 10 mm wide × 7 mm thick just below apex (*i.e.* slightly flattened, fleshy, slightly tapering to apex), smooth, green, flaring just below bracts to a receptacle which is 14–16 mm long, *c.* 10 mm diam. and which remains green after the bracts dry creating a sharp demarcation between the receptacle and pale bracts. *Involucral bracts* 2, free, initially green as peduncle emerges, soon dry and membranous by time of full emergence, prominently veined, acute; outer bract 50–59 mm long, 22–25 mm wide, broadly triangular, acute, with *c.* 26 veins at 1/3 height, the veins parallel, not reticulate; inner bract 48–60 mm long, 15–20 mm wide, slightly overlapping outer bract at base, with *c.* 19 veins at 1/3 height. *Floral bracts* filiform, usually 1 per flower but often not directly subtending a flower and sometimes 1 or 2 small bracts in centre not subtending a developed flower, 17–60 mm long, 1–7 mm wide, decreasing in size toward centre of inflorescence, membranous, white to sub-hyaline or partly translucent when fresh, papery and parchment-like when dry (mostly dry at anthesis). *Flower buds* pendulous, yellowish cream externally just before anthesis, *c.* 60 mm long, 10–18 mm diam., narrowly obovoid, acute. *Flowers* sessile, bright white inside and out at anthesis, suffused with pink then maroon to dark purple with age (or rapidly after picking), sweetly scented, with a slender tube and spreading tepal lobes; tube 85–120 mm long, *c.* 5 mm diam. at base, 4.0–4.5 mm diam. in middle, 3–4 mm diam. at apex, ±cylindrical but slightly tapering to apex, ±smooth but becoming very shallowly and broadly grooved near apex, nectar-filled, with an abscission ring present at base at maturity; outer corolla lobes narrowly elliptic to narrowly obovate or oblanceolate, 62–87 mm long, 11–18 mm wide (shrinking to *c.* 12 mm wide on wilting); apex attenuate, acute to acuminate, tending to infold along apex margins and somewhat hooded with a small, white, reflexed apical appendage 5.5–15.0 mm long; appendage apex 0.2 mm long, cylindrical to ±capitate and minutely to prominently papillose; inner corolla lobes 68–88 mm long, 13–15 mm wide (wilting to 12.5 mm), slightly smaller but similar in shape to outer lobes, lacking apical appendage. *Tepaline corona* absent. *Stamens* inserted at throat of perianth tube, subequal; filaments pinkish red to maroon in upper 1/2, usually white below, free, 35–57 mm long, filiform, fused to petals for *c.* 2 mm above corolla tube. *Anthers* greenish yellow, aging dark brown to black, 8.5–11.7 mm long, allantoid, medifixed, latrorse, turning inside out and frequently curving after anthesis; pollen yellow to orange. *Ovary* 3-locular, inferior, broadly spindle-shaped, green, 10–12 mm long, 6–7 mm diam., on a thick gynophore 2–4 mm long (sometimes appearing almost sessile); ovary beak absent; ovules *c.* 10 per loculus, in 2 rows. *Style* filiform, pinkish red to maroon, sometimes white in basal 1/2, exceeding stamens, 132–162 mm long, 0.7–0.9 mm diam., exceeding corolla tube by 67–72 mm, smooth, usually declinate; stigma shortly 2- or 3-lobed or sub-capitate, *c.* 1.3–2.2 mm diam., with a dense cluster of repeatedly dividing papillae. *Fruit* globular or irregular, 30–40 mm diam. *Seeds* 1–several, 7–10 mm across, irregular to subglobular. (Figure 1)

Diagnostic characters. Differs from all Australian species of *Crinum* L. by the following combination of characters: *leaves* U-shaped in section, 340–690 mm long, 5.1–11.7 mm wide, with a channel 5.5–10.7 mm deep; *inflorescence* arising adjacent to leaves, 2(–6)-flowered, buds pendulous; *perianth* tube 85–120 mm long, lobes 62–88 mm long, 11–18 mm wide; *flowers* bright white, suffused with maroon to dark purple with age.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 5 Jan. 2011, *M.D. Barrett* MDB 3237 (PERTH); 22 Feb. 2013, *M.D. Barrett* MDB 4003 (PERTH); 22 Feb. 2013, *M.D. Barrett* MDB 4006 (PERTH); 7 Jan. 1979, *J.A. Smith s.n.* (PERTH 03913465).

Phenology. Flowering and fruiting from January to May.

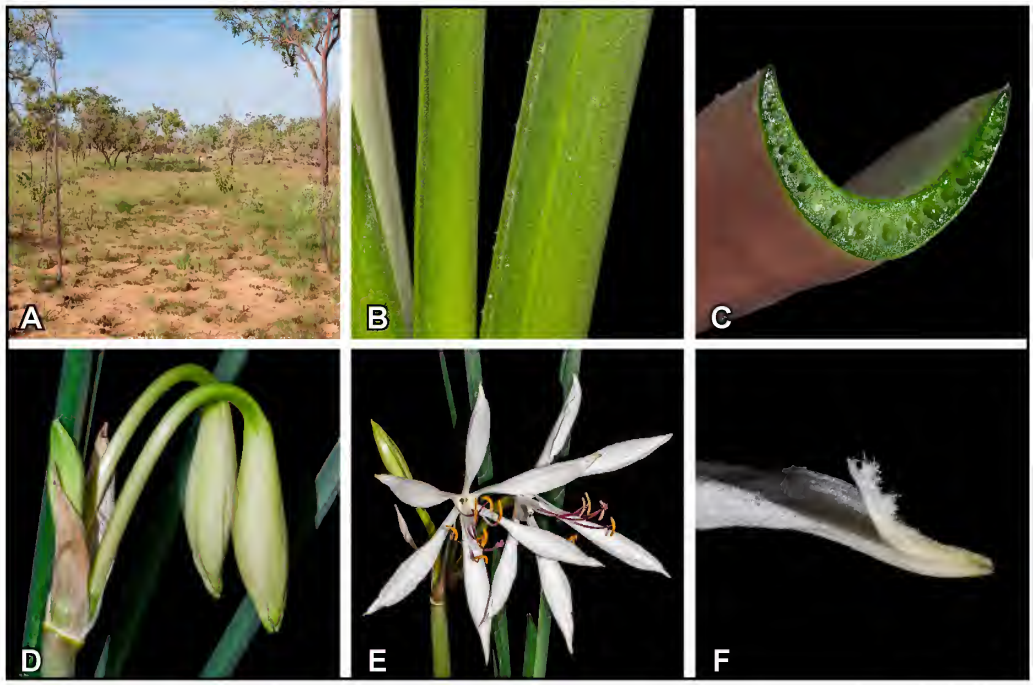

Figure 1. *Crinum joesmithii*. A – habitat of seasonally wet sand flats over sandstone; B – leaf, showing the marginal prickles; C – leaf section; D – buds; E – flowers; F – reflexed perianth appendage. Images from *R.L. Barrett* RLB 8344. Photographs by R.L. Barrett.

Distribution and habitat. Known from the Synnot Range, Edkins Range and headwaters of the Lawley River in the Kimberley region. Grows on seasonally wet sand flats on sandstone and in shallow, flooded soils over basalt. Recorded in association with *Alloteropsis semialata*, *Cochlospermum fraseri*, *Corymbia* spp., *Decaschistia occidentalis*, *Erythrophleum chlorostachys*, *Ipomoea* sp., *Owenia vernicosa*, *Terminalia canescens* and *Triodia* spp.

Conservation status. *Crinum joesmithii* is listed by Jones (2014) as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *C.* sp. West Kimberley (J.A. Smith s.n. 7/1/1979).

Etymology. The epithet recognises the collecting efforts of Joseph (Joe) A. Smith, formerly of Amax Exploration, who was the first to collect this species and a number of other new and unusual taxa from the Mitchell Plateau.

Notes. Morphologically, *C. joesmithii* appears intermediate between *C. uniflorum* F.Muell. (*sensu* Lehmiller *et al.* 2012a) and *C. arenarium* Herb.[1] Its leaves resemble juvenile (pre-fertile) leaves of *C. arenarium*, but it differs from this species in having 2(–6) flowers per peduncle (*vs* (3–)5–10 in *C. arenarium*), very narrow peduncles and leaves (*vs* peduncle 12–18 mm diam. in *C. arenarium*),

[1]As recognised by Govaerts (2015), the name *Crinum angustifolium* R.Br. (1810), widely used in Australian literature, is a later homonym of both *C. angustifolium* Houtt. (1780) and *C. angustifolium* L.f. (1782) and is therefore illegitimate. The next available name for this taxon is *C. arenarium* Herb. (1822). This matter has been confused by the recognition of both *C. angustifolium* R.Br. and *C. arenarium* Herb. by Lehmiller *et al.* (2012b) without adequate justification or discussion. Further studies of species boundaries in this group are recommended.

leaves 5.1–11.7 mm wide (*vs* 45–110 mm wide in *C. arenarium*), and more-slender tepals that age to pink and eventually maroon to dark purple before wilting (*vs* remaining white in *C. arenarium*). It differs from *C. uniflorum* in having 2(–6)-flowered inflorescences (*vs* 1-flowered in *C. uniflorum*), and flat (though incurved) rather than triquetrous leaves. The pendulous buds are unusual in the genus and are a character shared with *C. uniflorum* and *C. kakaduensis* Lehmiller & Lykos (they are spreading to reflexed in *C. arenarium*).

Crinum kakaduensis differs from *C. joesmithii* in having broader leaves 17–35 mm wide (*vs* 5.1–11.7 mm wide) and 3–12 flowers per inflorescence (*vs* 2(–6)), and grows in seasonally inundated clay soils (*vs* sand or basalt). *Crinum joesmithii* is also similar in general appearance to *C. yorkensis* Lehmiller, Lykos & R.Ham. from north Queensland, which differs in having distinctly pedicellate flowers (Lehmiller *et al.* 2012a).

Crinum joesmithii could be of hybrid origin and maintained by asexual reproduction. Its distribution is completely within that of *C. uniflorum* and it occurs in regions where *C. arenarium* is also common. *Crinum joesmithii* maintains both morphological differences and habitat preferences compared with both of these species. In the Kimberley, *C. arenarium* appears restricted to seasonally very wet soils (cracking clay plains, shallow swamps or creek margins) while *C. uniflorum* occurs on flat, alluvial soils associated with small creeks and swamp overflows. *Crinum joesmithii* occurs most commonly on deep sand flats derived from sandstone (once recorded in shallow black soil over basalt). Both *C. uniflorum* and *C. joesmithii* occur on the Synnot Range on Charnley River Station, where *C. uniflorum* is confined to silt-rich alluvial flats associated with Lake Gilbert.

The vernacular name Kimberley Crinum Lily is suggested.

Proiphys kimberleyensis M.D.Barrett & R.L.Barrett, *sp. nov.*

Type: cultivated: Kings Park and Botanic Garden [from specimens collected on the Mitchell Plateau], Western Australia [precise locality withheld for conservation reasons], 31 January 2014, *R.L. Barrett* RLB 8343 [flowering specimen] (*holo*: PERTH 08614539; *iso*: CANB).

Paratype: Mitchell Plateau, Western Australia [precise locality withheld for conservation reasons], 24 January 2010, *R.L. Barrett & M.D. Barrett* RLB 6375 [leaf specimen] (*para*: PERTH 08617392).

Illustrations. B.L. Koch in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1002, Figure 300B, C (1992), as both *P. alba* (R.Br.) Mabb. and *P. amboinensis* (L.) Herb.

Glabrous geophytic *perennial* with a ±globular bulb; daughter bulbils present, aggregated in groups of 1–3, green, globular, large, smooth, rupturing irregularly at maturity. *Leaves* basal, expanding after flowering (not visible at anthesis), channelled above, to 490 mm long above ground level; petiole *c.* 190 mm long (above ground), 7–9 mm wide, 6.5–9.0 mm deep, ±terete but flattened to shallowly grooved on upper side, variously becoming more flattened or more grooved closer to blade, gradually merging into blade; blade thick, coriaceous, initially dark green becoming sub-glaucous in cultivation (often ±glaucous in field), narrowly elliptic to broadly ovate, (120–)200–275 mm long, (55–)80–140 mm wide, flat, with prominent midvein slightly raised above, distinctly raised below; primary venation curved, secondary venation parallel, with *c.* 7 or 8 primary veins across each side of midblade; base cuneate to truncate; apex sub-obtuse (*c.* 110°), with an abrupt, small, rounded apiculus. *Inflorescence* a scapose, terminal umbel, arising before the leaves; cataphylls 2, ±opposite,

protruding *c.* 10–35 mm above the ground, 5–15 mm wide, triangular-subulate, acute, membranous to thick-fleshy along midrib, lacking a blade, only slightly sheathing at base, thick, ±succulent; peduncle 450–670 mm long, 6–13 mm diam. at base, 6.5–7.0 mm diam. at apex, smooth, dark green, terete to slightly rounded-irregular in section; umbel with 17–21 flowers, erect to spreading. *Involucral bracts* 2 or 3, ±opposite (±equally spaced when 3), 36–60 mm long, 10.5–14.0 mm wide, free, narrowly ovate to narrowly triangular, acute, imbricate, sub-membranous, pale yellow and thin even when young; ±sharply to indistinctly grading into the floral bracts. *Floral bracts* 1 per flower (not always obviously subtending a flower at maturity), 12–33 mm long, 0.5–5.0 mm wide, triangular to linear, acute, white. *Pedicels* 24–71 mm long, green, terete, cylindrical, smooth. *Flower buds* obovoid-pyriform, *c.* 25 mm long, 8 mm diam. just prior to anthesis. *Flowers* sweetly scented, actinomorphic, bright white. *Corolla* funnel-shaped, 20–44 mm diam.; *tepals* pure white, connate at the base, the floral tube thus formed cylindrical to very narrowly conical, 14–20(–23) mm long but usually uniform in length within an umbel, 2.5–2.9 mm diam. just above ovary, 2.8–4.0 mm diam. at mid-point, 3.6–5.0 mm diam. at base of tepals, campanulate above tube, not or scarcely infundibuliform, slightly ribbed in upper part as inner tepals arise slightly inside level of outer tepals, glabrous internally and externally; tepal lobes subequal, not to strongly overlapping laterally, spreading, held at 30–45° to the style; outer lobes 21–31 mm long, 8.5–16.0 mm wide, narrowly elliptic to moderately obovate; inner lobes *c.* 2 mm shorter, apiculate, broadly elliptic to obovate, 19–30 mm long, 7.5–14.0 mm wide; tepaline corona absent. *Stamens* inserted in the throat of the perianth tube, level with tips of inner tepals or a little exserted; filaments expanded at the base and connate for 3.5–8.0 mm into a corona; corona white or yellow inside at base, 9–13 mm long, with 2 apical corona lobes between each filament, the lobes erect or spreading, 3.5–6.5 mm long with acute apices, each pair of corona lobes connate for most of their length with a notch 1.0–4.0 mm deep; free portion of filaments 8–14 mm long; anthers sub-medifixed at 1/3–2/5 from base, introrse, straight, 3.0–4.4 mm long when fresh, initially held erect then becoming more curved, versatile and lateral with age; pollen dark yellow. *Ovary* green, inferior, with withered flowers remaining attached for some time, globular, becoming ellipsoid in late anthesis, to *c.* 8 mm long, 3.5–4.0 mm diam., 1- or 2-locular; ovules 2 per locule, rounded, basally attached, each pair on a common fleshy stalk attached to a large, fleshy pad forming the basal part of the septum, held in the upper 1/2 of the ovary. *Style* filiform, equal to or usually exceeding anthers, white, 36–50 mm long, exserted 19–29 mm from the base of corona; stigma not expanded. *Fruits* globular, 15–20 mm diam., each producing several irregularly shaped bulbils. (Figure 2)

Diagnostic characters. Distinguished from all other species of *Proiphys* Herb. by the following combination of characters: *leaves* thick, coriaceous, narrowly elliptic to broadly ovate, and cuneate to truncate at base; *flower stalk* arising without leaves, which appear after anthesis of all flowers; *involucral bracts* pale yellow; *flowers* 17–21 per umbel; *stamen* filaments united for 3.5–8.0 mm; *corolla* tube 14–20(–23) mm long.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 21 Dec. 2011, *M.D. Barrett* MDB 3235 (CANB, CNS, DNA, PERTH); 24 Jan. 2010, *R.L. Barrett & M.D. Barrett* RLB 6375 (PERTH); 16 Oct. 1981, *T.P. Farrell* 970 (BRI *n.v.*, PERTH); 4 Feb. 1979, *K.F. Kenneally* 7017 (PERTH); 4 Dec. 1978, *J.A. Smith s.n.* (PERTH 03914194); 13 Jan. 1984, *J.A. Smith s.n.* (PERTH 03914151); 16 May 1985, *I.R. Telford* 10087 (CBG); 16 May 1985, *I.R. Telford* 10088 (CBG); 10 Jan. 1979, *E. Wittwer* S 4440 (PERTH).

Phenology. Flowering recorded in October and from December to February. Fruiting recorded in January.

Distribution and habitat. Recorded from three populations on the northern Mitchell Plateau and Lawley River valley (south-east of the Mitchell Plateau) in the Kimberley region. Grows in shallow,

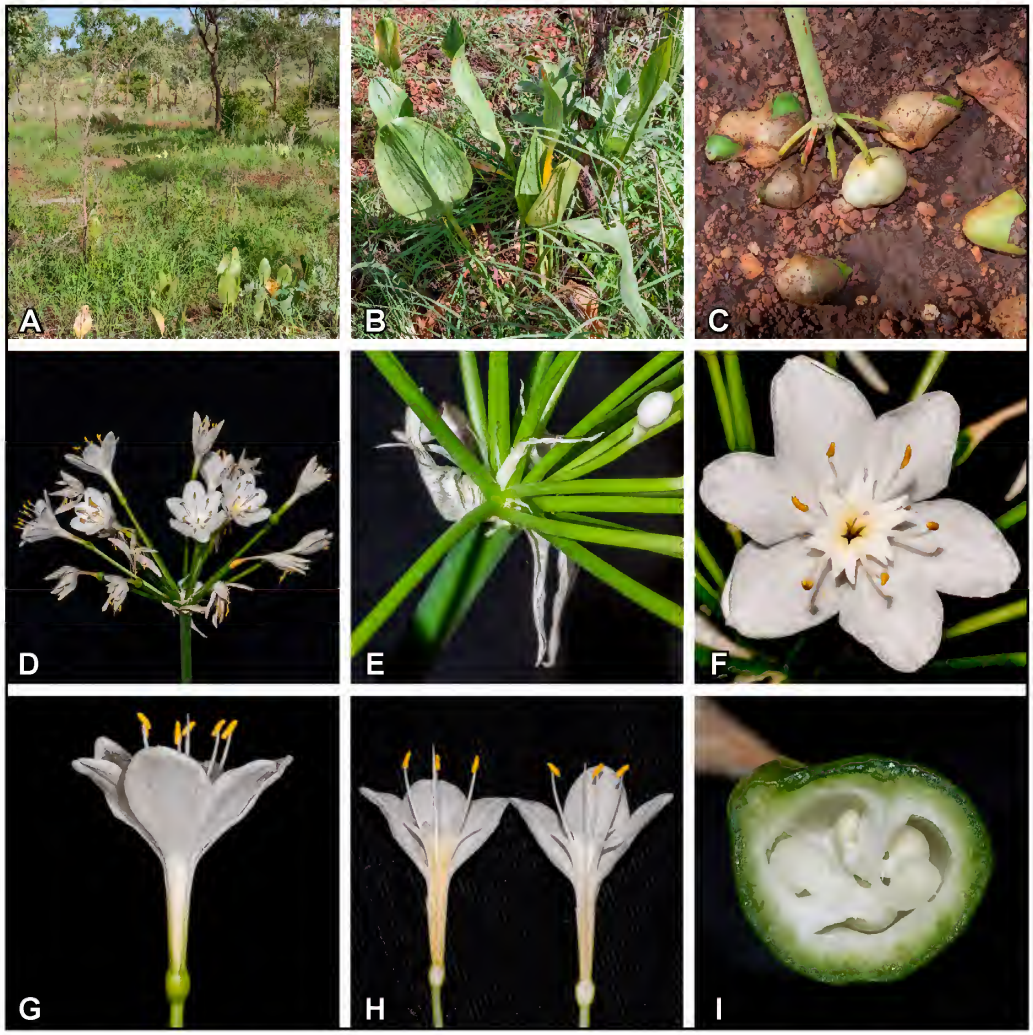

Figure 2. *Proiphys kimberleyensis*. A – habitat of open woodland on shallow basalt soils over massive sheeting basalt; B – leaves; C – infructescence; D – inflorescence; E – inflorescence bracts; F – flower showing staminal corona and versatile anthers; G – lateral view of flower showing imbricate tepals; H – dissected flower; I – cross-section of ovary. Images from *R.L. Barrett & M.D. Barrett* RLB 6375 (A–C) and *R.L. Barrett* RLB 8343 (D–I). Photographs by R.L. Barrett.

red clay soils over massive basalt pavements in low, open woodland of *Corymbia latifolia*, *Livistona eastonii* and *Terminalia canescens* over *Chrysopogon* sp., *Cleome* aff. *tetrandra*, *Cyperus* sp., *Eriosema chinense*, *Fimbristylis schultzii*, *Gossypium australe*, *Haemodorum macfarlanei*, *Heliotropium* sp., *Jacquemontia* spp., *Pimelea concreta*, *Polymeria* sp. A Kimberley Flora (T.E.H. Aplin et al. 418), *Rostellularia clementii*, *Synostemon* sp., *Tricoryne* sp. Kimberley (K.F. Kenneally 4857), *Triodia claytonii* and *Typhonium liliifolium*.

Conservation status. *Proiphys kimberleyensis* is to be listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). While this species is sometimes locally abundant in very small patches, it is very rarely collected and only one population of about 500 plants has been seen since 1981.

Etymology. The epithet refers to the Kimberley region of Western Australia where it is apparently endemic.

Notes. As this species flowers prior to leaf development and both leaves and flowers are important for identification, a paratype has been designated based on a leaf collection from the original population that the type was cultivated from.

Apparently most similar to *P. amboinensis* (L.) Herb., a relatively widespread species ranging from north Queensland through Malesia and to the Moluccas (Ambon). It differs in having thick, coriaceous (thin and flexible in *P. amboinensis*), differently shaped leaves (elliptic to suborbicular and cuneate to truncate at base *vs* suborbicular to reniform and weakly to distinctly cordate at base in *P. amboinensis*). In *P. kimberleyensis*, the flower stalk arises without leaves (leaves only arising after anthesis of all flowers) whereas leaves arise coincident or soon after the flower stalk and apparently begin to unfurl during (at least late) anthesis in *P. amboinensis*. Floral dimensions are similar between the two species (*cf.* Geerinck 1993; Jones & Dowe 2001).

Proiphys alba (R.Br.) Mabb. differs in having linear to lanceolate leaves (elliptic to suborbicular in *P. kimberleyensis*) and a shorter corolla tube 8–15 mm long (14–20(–23) mm long in *P. kimberleyensis*).

This species has been poorly known, with specimens previously incorrectly assigned to either *P. alba* or *P. amboinensis* by Telford (1987) and Koch (1992), even though most collections probably originate from a single population. Most of the fertile material known has been cultivated at either the Western Australian Herbarium or at Kings Park and Botanic Garden, initially based on specimens collected by Joseph Smith, who collected the first known specimens in 1978 while working for the Amax Exploration Company. Our field examination of the type population showed that leaf blade shape on individual plants is extremely variable, ranging from elliptic-oblong and almost as narrow as the broadest extreme of *P. alba*, through to almost as broad (but never cordate) as blades of *P. amboinensis*. Depending on the leaf shape of the collected plant, earlier collections were assigned to either *P. alba* or *P. amboinensis*, and the few available collections did not permit deduction that they belonged to a continuum. A further complication was the paucity of flowering collections, all from cultivated material, which differed greatly in flower size. This is possibly an artefact of cultivation in a temperate climate, but flowering field collections are required to test this hypothesis.

The vernacular name Kimberley Proiphys is suggested.

There is a single collection (*R.L. Barrett* RLB 757) at PERTH of true *P. amboinensis* from the Kimberley, a cultivated plant from a garden at Beverley Springs Station Homestead. This species is not known to be naturalised in Western Australia.

Five species are now recognised in the genus and a key to all species is provided below.

Key to *Proiphys* species (partly adapted from Jones & Dowe 2001)

1. Involucral bracts green. Flowers 5–12 per umbel. Stamen filaments united (from base to first level of divison) for 12–16 mm. Leaf blade broadly ovate, tapered, rounded or occasionally shallowly cordate at base. (SE Qld, NSW) ..... **P. cunninghamii**

1: Involucral bracts white. Flowers 5–30 per umbel. Stamen filaments united (from base to first level of division) for 2–12 mm. Leaf blade variable, from linear to broadly ovate or reniform, cordate at base or not..... **2**

2. Leaf blade broadly ovate to reniform, cordate or subcordate at base, at least in mature leaves **3**

2: Leaf blade linear to ovate or rarely broadly ovate, cuneate or sometimes broadly obtuse at base, but never cordate **4**

3. Flowers erect, funnel-shaped. Corolla lobes narrowly imbricate. Stamen filaments 18–30 mm long. (Qld) ..... **P. infundibularis**

3: Flowers porrect, bell-shaped. Corolla lobes widely separated. Stamen filaments 7–12 mm long. (Qld, Malesia, Thailand, Philippines, Indonesia, Moluccas (Ambon), PNG) ..... **P. amboinensis**

4. Leaves elliptic to suborbicular. Corolla tube 14–20(–23) mm long..... **P. kimberleyensis**

4: Leaves linear to lanceolate. Corolla tube 8–15 mm long. (Qld, NT (Islands in Gulf of Carpentaria), PNG) ..... **P. alba**

Araliaceae

Trachymene pavimentum M.D.Barrett & R.L.Barrett, *sp. nov.*

Type: Theda Station, Western Australia [precise locality withheld for conservation reasons], 23 February 2005, *M.D. Barrett* MDB 1661 (*holo*: PERTH 08043531, *iso*: BRI, CANB, CNS, DNA, K, MEL, NSW).

Trachymene sp. Theda (M.D. Barrett MDB 1661), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Erect to spreading, short-lived annual *herb* 10–30 cm high, with indumentum of sparse to very sparse, simple, non-glandular trichomes 0.5–2.5 mm long on leaves including petioles. *Leaves* cauline, alternate; *petiole* 11–21 mm long; *lamina* obovate in outline, 5–27 mm long, 8–32 mm wide, ternately dissected, divided almost to base into 3 segments, each additional level of division mostly with (2)3 ±equal parts; segments linear to oblanceolate, thin, 0.5–1.8 mm wide at their broadest, each with a single, narrow midnerve. *Umbels* solitary, held shortly above the leaves, 5–9 mm diam., 18–51-flowered. *Peduncle* 5–70 mm long. *Bracts* linear, entire, 3–7 mm long, 0.3 mm wide, or leaf-like and 3-segmented, the segments up to 12 mm long, 0.5 mm wide. *Involucral bracts* free, 8–12, 2.5–4.0 mm long, linear-subulate, glabrous. *Pedicels* 2.1–3.5 mm long, ±filiform, glabrous. *Sepals* inconspicuous, *c.* 0.1 mm long, linear-subulate. *Petals* 5, orbicular to suborbicular, 0.6–0.7 mm long, 0.5–0.6 mm wide, white aging apricot, mostly glabrous but minutely papillose (papillae *c.* 0.1 mm long) on the floral rim. *Staminal filaments* 0.5 mm long, terete, glabrous; *anthers c.* 0.20–0.25 mm long, *c.* 0.2 mm diam., glabrous. *Ovary* unilocular. *Carpels* glabrous. *Styles* 2, 0.6–0.8 mm long. *Fruiting umbel* 6–9 mm across. *Fruit* composed of only 1 mericarp; mericarp laterally compressed, 1.8–2.1 mm long, 0.7–1.0 mm wide, elliptic, smooth, glabrous; wing absent; carpophore entire, slightly tapering, 0.8–1.5 mm long. (Figure 3)

Diagnostic characters. Distinguished from all tropical species of *Trachymene* Rudge by the following combination of characters: short-lived *annual* herb 10–30 cm high with indumentum of simple, non-glandular trichomes; *leaves* deeply ternately dissected with ±linear segments <2 mm wide; *involucral bracts* linear-subulate, glabrous; *flowers* in solitary umbels of 18–51 flowers and held shortly above the leaves; *petals* white aging apricot; *fruit* composed of 1 smooth, glabrous mericarp.

Other specimen examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 28 Mar. 2011, *M.D. Barrett* MDB 3358 (BRI, CANB, DNA, NY, PERTH).

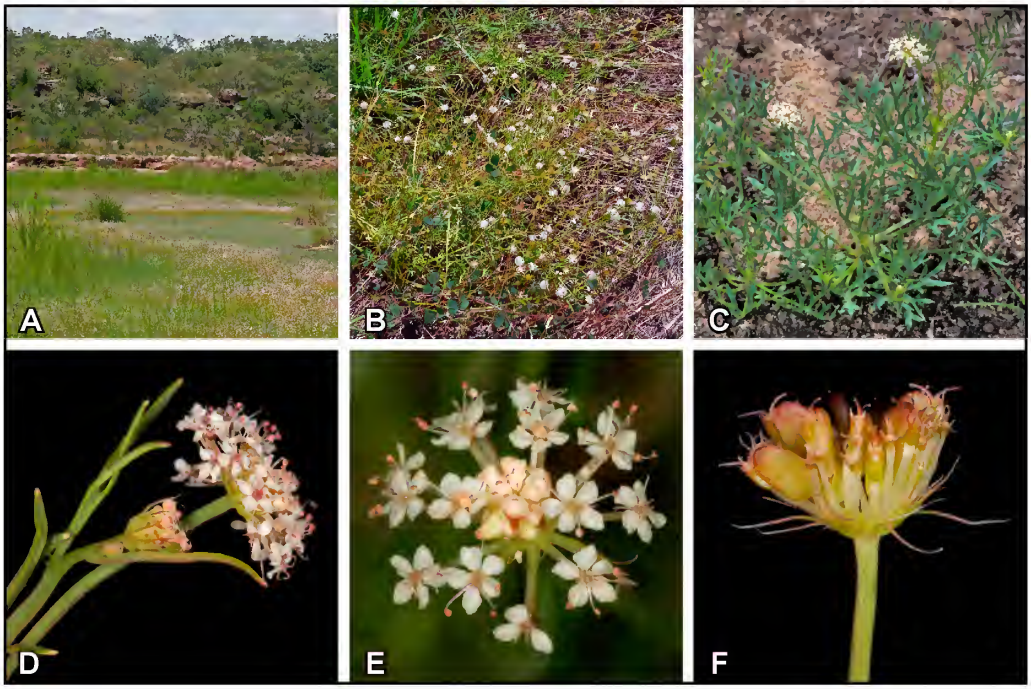

Figure 3. *Trachymene pavimentum*. A – habitat of thin sand sheets on massive sheeting sandstone; B – habit; C – habit showing dissected leaves; D – lateral view of inflorescence and buds; E – inflorescence; F – infructescence. Images from *M.D. Barrett* MDB 3358 (B) and *M.D. Barrett* MDB 1661 (C–F). Photographs by R.L. Barrett (A, D–F); M.D. Barrett (B, C).

Phenology. Flowering and fruiting plants collected in February and March.

Distribution and habitat. Known from a single location on Theda Station, growing in skeletal sand over massive sheeting sandstone, with *Drosera* spp., *Eriachne* spp., *Fimbristylis* spp. and *Rhynchospora* sp. Arnhem (P.K. Latz 2999).

Conservation status. *Trachymene pavimentum* is listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *T.* sp. Theda (M.D. Barrett MDB 1661). Hundreds of plants were present at the time of both collections, but they were restricted to an area *c.* 20 m across. It has not been found elsewhere on the same pavement, nor in other similar habitats nearby, despite extensive surveys in the area over a period of 14 years.

Etymology. The epithet is derived from the Latin *pavimentum* (a floor of stones) used as a noun in apposition, in reference to the sheeting sandstone pavement where the species grows.

Notes. Differs from all other Kimberley *Trachymene* species in being a small, short-lived (8–12 weeks) annual (*vs* robust perennial or biennial). *Trachymene pavimentum* is morphologically closest to *T. microcephala* (Domin) B.L.Burtt (to which it would key in Hart and Henwood 2006: 20), which differs in being a robust perennial to 70 cm tall with 30–70-flowered umbels in cymose inflorescences held well-above the basal leaves, and papillose mericarps.

The vernacular name Pavement Laceflower is suggested.

Commelinaceae

Commelina roensis M.D.Barrett & R.L.Barrett, *sp. nov.*

Type: Roe River pavement, Western Australia [precise locality withheld for conservation reasons], 23 April 2008, *R.L. Barrett & M.D. Barrett* RLB 4633 (*holo*: PERTH 08104956; *iso*: AD, CANB, DNA).

Commelina sp. Roe River (R.L. Barrett & M.D. Barrett RLB 4633), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Perennating *herb* with prostrate, scrambling or ascending annual stems to 40 cm long which are glabrous or shortly multicellular-hairy on one side for some distance below nodes. *Leaves*: *sheath* 3–5 mm long, with strongly raised veins; *blade* lanceolate, 13–30 mm long, 4–6 mm wide, undulate, acute, pale green, with a prominent midrib, sparsely to moderately pilose with multicellular hairs 0.5–1.4 mm long. *Inflorescences* borne singly in leaf axils; *peduncles* 3–16 mm long, sparsely to moderately hairy. *Spathe* 12–15 mm long, 4.0–5.5 mm wide when folded, *c.* 9 mm wide and broadly ovate with weakly to strongly cordate base and abruptly acuminate apex (if flattened), pilose outside, glabrous inside, open to the base (not fused along the basal margins); margins of the broadest portion with a sparse fringe of tubercle-based multicellular hairs up to 1.4 mm long, but these scarcely differentiated in length or density from the surface hairs; veins not prominent or raised, only the midvein conspicuously keeled. *Cymes* 2 per spathe, each 1-flowered (so always 2 flowers per spathe); lower cyme with an axis 6–7 mm long, the flower always exserted from the spathe (lost or withered in type specimen and possibly functionally male?); upper cyme on an axis 4.0–6.5 mm long and usually developing a capsule inside the spathe. *Pedicels c.* 1.5 mm long. *Flowers c.* 2 cm across. *Calyx* segments *c.* 4.5 mm long, the upper slightly shorter than the lower, all fused ±equally at base, glabrous, muticous at apex. *Petals* 3, subequal in size and shape (none reduced), blue. *Stamens* and staminodes 3. *Ovary* 2-locular, with 2 ovules in each loculus. *Capsule* ovoid, 4–5 mm long, 3.5–4.0 mm diam., usually maturing 1 seed per loculus (i.e. 2 seeds per capsule). *Seeds* ±obloid to sub-reniform, 3.5–3.8 mm long, obtusely 3-angled in section, dull, with scattered, shallow, broad depressions, the centre of depressions with a demarcated zone of small pits. (Figure 4)

Diagnostic characters. Distinguished from all Australian species of *Commelina* L. by the following combination of characters: *leaves* short, the blades 13–30 mm long; *spathes* open to the base, the margins ciliate but not conspicuously hairier than the spathe surfaces; *petals* subequal in size and shape; *ovules* 2 per loculus; *seeds* ±obloid to sub-reniform with scattered, shallow, broad depressions.

Other specimens examined. Known only from the type collection.

Phenology. Very last flowers of the season and fruits observed in late April.

Distribution and habitat. Grows in the vicinity of the Roe River, in sand in damp places on sandstone slopes, in a broader vegetation association including *Byblis filifolia*, *Calandrinia* sp., *Centrolepis exserta*, *Cleome* aff. *kenneallyi*, *Cucumis umbellata*, *Cyperus* spp., *Eriachne* sp., *Eriocaulon* sp., *Ficus platypoda*, *Fimbristylis* spp., *Goodenia* sp., *Phyllanthus minutiflorus*, *Polycarpaea breviflora*, *Polycarpaea involucrata*, *Ptilotus polystachyus*, *Scaevola* sp., *Schizachirium* sp., *Solanum* sp., *Sorghum* sp., *Spermacoce* spp., *Stylidium perizostera*, *S. rivulosum*, *Triodia bynoei* and *Xyris* sp.

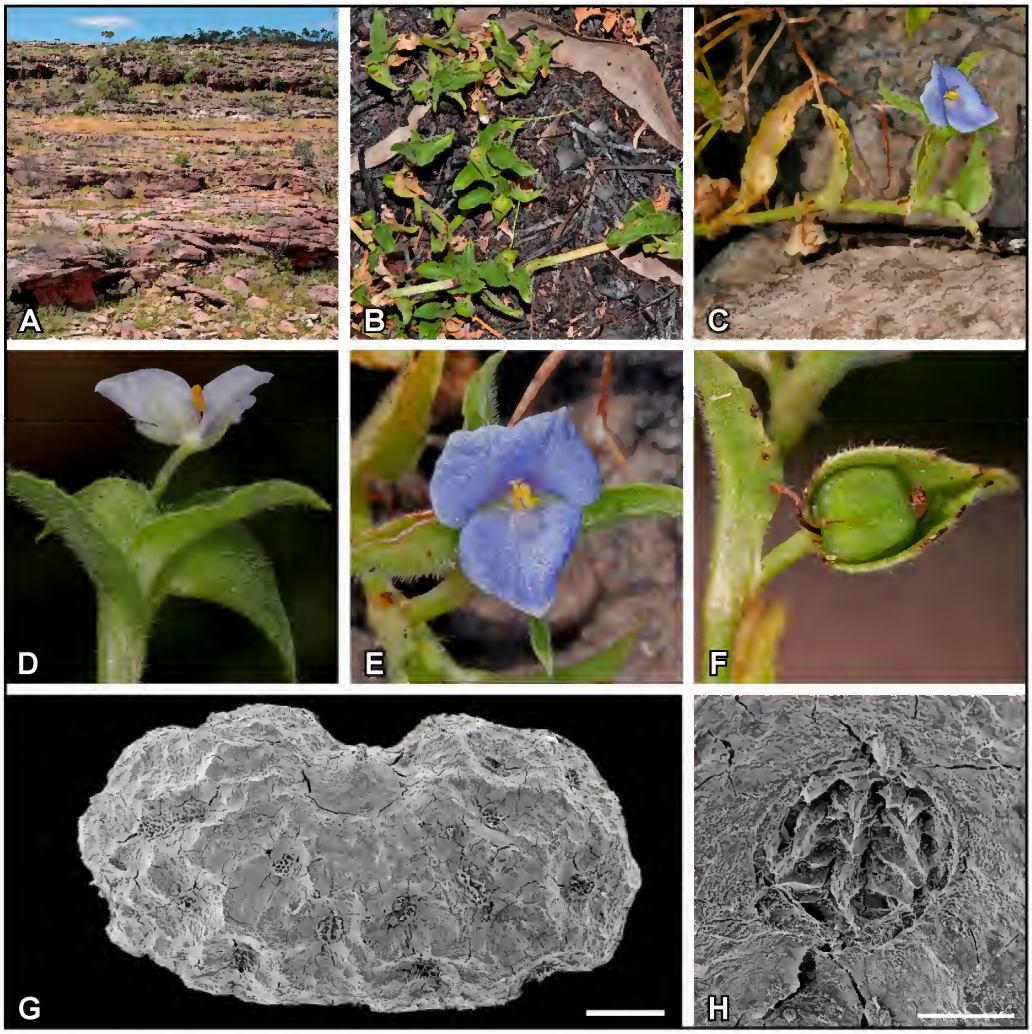

Figure 4. *Commelina roensis*. A – habitat of sandstone step-pavements on side of ridge at type location; B – habit; C – flowering branch; D – lateral view of inflorescence; E – flower; F – fruit; G – SEM of seed; H – SEM of bounded pit on seed surface. Scale bars = 1 mm (G); 100 μm (H). Images from *R.L. Barrett & M.D. Barrett* RLB 4633. Photographs by R.L. Barrett (A–C); M.D. Barrett (D–H).

Conservation status. *Commelina roensis* is listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *C.* sp. Roe River (R.L. Barrett & M.D. Barrett RLB 4633). Only one group of *c.* 10 plants was found at the type locality.

Etymology. The epithet refers to the Roe River near which this species was discovered.

Notes. Of the *Commelina* species known from northern Australia, *C. roensis* differs from *C. ensifolia* R.Br. and *C. benghalensis* L. in having the spathe open at the base (fused in the latter two species). *Commelina reticulata* Stanley and *C. tricarinata* Stanley have reticulate seeds and occur on cracking clay plains (seeds with broad, shallow depressions and sandstone habitat in *C. roensis*). *Commelina agrostophylla* F.Muell. and *C. ciliata* Stanley have seeds that are smooth or minutely papillose without broad depressions, and longer leaves mostly >30 mm long. *Commelina lanceolata* R.Br.

and *C. diffusa* Burm.f. have pitted seeds, unequal stamens and 3–5-seeded fruit (seeds with broad, shallow depressions, equal stamens and 2-seeded fruit in *C. roensis*) and leaf blades mostly >30 mm long (13–30 mm long in *C. roensis*).

Commelina roensis is probably most similar to *C.* sp. Sandstone (R.J. Fensham 739) which occurs in sandstone areas of Litchfield National Park in the Northern Territory, but differs in having ±obloid to sub-reniform, obtusely 3-angled seeds with broad, shallow depressions (elliptic, compressed and lacking regular broad depressions in *C.* sp. Sandstone), and in having more uniformly hairy spathe surfaces, as well as smaller leaves (24–41 mm long, 3.6–5.0 mm wide in *C.* sp. Sandstone) with undulate margins.

The vernacular name Roe River Commelina is suggested.

Cyperaceae

Caustis deserti R.L.Barrett, *sp. nov.*

Type: north-east of Queen Victoria Spring, Western Australia [precise locality withheld for conservation reasons], 18 October 1995, *D.J. Edinger* 1019 (*holo*: PERTH 04241525).

Rhizomatous *perennial*; rhizome scales dark brown. *Culms* rigidly erect, smooth, distinctly grooved on one side, with 5–10 nodes, 21–38 cm tall, the primary culms 1.6–2.8 mm diam., glabrous; *infertile nodes* 5–8 per culm, each with 1–5 lateral branches, the ultimate branchlets (sterile pedicels) straight or slightly flexuose, tightly clustered, 0.8–1.5 mm diam. *Leaves* of mature plants reduced to dark brown, many-nerved sheathing scales with acuminate apiculum, 12–30 mm long; sheath margins very shortly ciliate; sheath and both surfaces of apiculum minutely puberulous when young, glabrescent. Young *flowering branches* somewhat contracted at first (eventually expanding, but the inflorescence remaining narrow), not or somewhat flexuose. *Spikelets* 25–46 per inflorescence, 9.5–17.0 mm long, usually 2-flowered, bisexual; glumes 3–5, white or pale to dark brown with opaque margins, long-acuminate, sparsely to densely appressed- to spreading-hairy particularly at base and on margins. *Stamens* 3 (but anthesis simultaneous in both flowers so 6 per spikelet); *filaments* 7–9 mm long; *anthers* 5.3–6.2 mm long including apiculum *c.* 0.4 mm long, 0.25 mm diam., reddish brown when dry; *pollen* triquetrous. *Style* 3-fid, hairy at base, *c.* 6 mm long, the branches *c.* 5.5 mm long. Mature *nut* not seen. (Figure 5)

Diagnostic characters. Distinguished from other species of *Caustis* R.Br. by the following combination of characters: rhizomatous *perennial* 21–38 cm tall; *culms* rigidly erect, the primary culms 1.6–2.8 mm diam., 1–5-branched at each node; *leaves* reduced to sheathing scales 12–30 mm long; *spikelets* 25–46 per inflorescence, 9.5–17.0 mm long, usually 2-flowered; *anthers* 5.3–6.2 mm long including apiculum, *c.* 0.4 mm long, 0.25 mm diam., reddish brown when dry.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 14 Sep. 1995, *A. Chapman & D. Pearson* 49 (PERTH); 21 Sep. 1963, *A.S. George* 5878 (PERTH); 2 July 1966, *D.W. Goodall* 2949 (PERTH); 24 Mar. 1987, *D.J. Pearson* DJP 1068 (PERTH); 17 May 1992, *D.J. Pearson* DJP 1820 (PERTH); 28 July 1992, *D.J. Pearson* DJP 2236 (PERTH); 7 Sep. 1992, *D.J. Pearson* DJP 2781 (CANB, PERTH); 2 Oct. 1956, *R.D. Royce* 5532 (PERTH).

Phenology. Flowering recorded in September and October.

Distribution and habitat. Known only from the vicinity of Queen Victoria Spring to Cundeelee Mission (abandoned) in the southern Great Victoria Desert. Grows in low heath on yellow to orange sand plains.

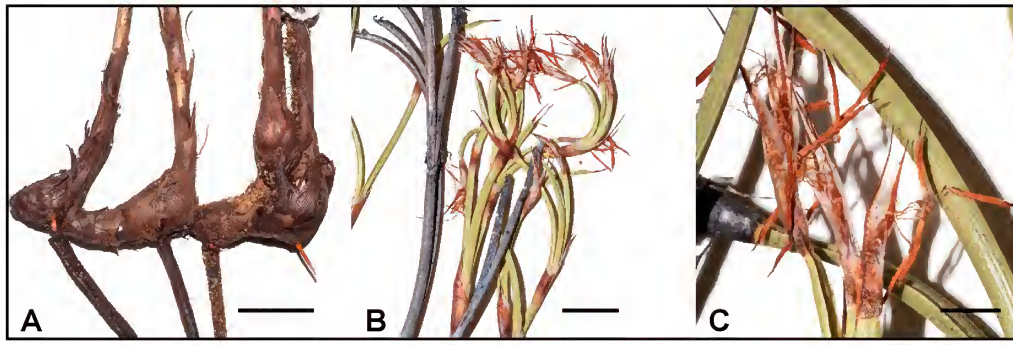

Figure 5. *Caustis deserti*. A – rhizome; B – flowering branchlets; C – spikelets and anthers. Scale bars = 1 cm. Images from *D.J. Edinger* 1019. Photographs by R.L. Barrett.

Conservation status. *Caustis deserti* is to be listed as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.).

Etymology. The epithet is the genitive case of the Latin noun *desertum* (a desert), in reference to the occurrence of this species in the Great Victoria Desert.

Notes. *Caustis deserti* is similar to *C. dioica* R.Br., but is distinctly more robust, with a shorter stature and fewer branches (culms 28–65 cm tall, the primary culms 1.7–3.1 mm diam. with 4–7 branches in *C. dioica*). The anthers of *C. deserti* are 5.3–6.2 mm long, *vs* 3.0–4.5 mm long in *C. dioica*.

Caustis dioica is a rather variable taxon and it is likely that additional taxa should be recognised in this complex; for example, low, slender plants co-occur with tall, robust plants in the Cape Riche area.

The vernacular name Desert Twigrush is suggested.

Caustis gigas Meney & K.W.Dixon ex R.L.Barrett, *sp. nov*.

Type: Coorow – Green Head Road, Western Australia [precise locality withheld for conservation reasons], 14 May 1969, *A.S. George* 9318 (*holo*: PERTH 01278274; *iso*: AD, BM, BOL, BRI, CANB, GENT, HO, K, MEL, NE, NSW, NY, PERTH 01121332, PERTH 01278282).

Caustis sp. Gigas (A.S. George 9318), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Rhizomatous *perennial*; rhizome scales dark brown. *Culms* rigidly erect, smooth, distinctly grooved on one side, with 5–15+ nodes, 0.7–2.5 m tall, the primary culms 2.2–5.0 mm diam., finely ciliate towards nodes, densely so in groove, glabrescent; *infertile nodes* 5–10 per culm, each with 1–3(–4) lateral branches, the ultimate branchlets (sterile pedicels) straight or flexuose, widely spreading, 0.7–1.4 mm diam. *Leaves* of mature plants reduced to dark brown, many-nerved sheathing scales with acuminate apiculum, 12–42 mm long; sheath margins distinctly long-ciliate; sheath and both surfaces of apiculum densely appressed-puberulous when young, glabrescent outside. Young *flowering branches* forming a pseudo-raceme of 3–12 spikelets, not contracted (narrow at first, the branches and branchlets greatly expanding), somewhat flexuose. *Spikelets* 30–300 per inflorescence, 10–16 mm long, 2–5-flowered, bisexual; glumes 5–8, dark brown, with non-opaque margins, long-acuminate, densely appressed- to

spreading-hairy all over with spreading ciliate margin. *Stamens* 3 (but anthesis simultaneous in all flowers, so up to 15 per spikelet); *filaments* 6.2–7.9 mm long; *anthers* 5.9–7.7 mm long including apiculum *c.* 0.5 mm long, *c.* 0.35 mm diam., reddish brown when dry; *pollen* triquetrous. *Style* 3-fid, hairy at base, *c.* 6.5 mm long, the branches 3.9–4.3 mm long; style base at maturity persistent, spindle-shaped and covered in short, erect hairs. Mature *nut* obovoid, cream, 8.9–9.8 mm long, 2.6–3.0 mm diam., the perianth forming a small rim fused to base of nut. (Figure 6)

Diagnostic characters. Distinguished from other species of *Caustis* by the following combination of characters: robust, erect, rhizomatous *perennial* to 2.5 m; *culms* rigidly erect, the primary culms 2.2–5.0 mm diam., with *infertile nodes* 5–10 per culm; *spikelets* 30–300 per inflorescence, 10–16 mm long, 2–5-flowered; *anthers* 5.9–7.7 mm long including apiculum *c.* 0.5 mm long, *c.* 0.35 mm diam., reddish brown when dry; *nut* 8.9–9.8 mm long, 2.6–3.0 mm diam.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 18 Oct. 2008, *R.L. Barrett & B.G. Briggs* RLB 5257 A (AD, BRI, CANB, NE, MEL, NSW, PERTH); 2 May 1973, *C. Chapman s.n.* (PERTH 01278304); 1 May 1991, *R.J. Cranfield & P.J. Spencer* 8001 (PERTH); Aug. 1988, *K. Gillen* 27 (PERTH); 12 Oct. 2005, *A. Harris* NL Opp 11 (PERTH); 3 Nov. 2006, *K. McCreery, V. Yeomans & A. Mercier* RV 4 - opp 2 (PERTH); 29 Aug. 1991, *S.J. Patrick* 733 (PERTH); 6 Aug. 1992, *S. Patrick* SP 1167 (PERTH); 5 July 2002, *S. Patrick* 4136 (PERTH); 9 Oct. 2002, *S. Patrick* SP 4472 (PERTH).

Phenology. Flowering from May to July. Fruiting from August to October.

Distribution and habitat. Restricted to a small area of the northern sandplain between Coorow and Chittering in south-western Western Australia. Grows on white sandplain below lateritic rises with *Adenanthos cygnorum*, *Banksia candolleana*, *Banksia glauca*, *Darwinia* sp., *Eucalyptus todtiana*, *Hakea smilacifolia*, *Hibbertia hypericoides*, *Hibbertia* sp., *Lambertia multiflora*, *Leucopogon oldfieldii*, *Petrophile ericifolia*, *Petrophile* sp. and *Xanthorrhoea* sp.

Conservation status. *Caustis gigas* is listed by Jones (2014) as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *C.* sp. Gigas (A.S. George 9318). Most collections have been made from a single locality.

Etymology. The epithet is from the Latin *gigas* (a giant), used as a noun in apposition, in reference to the tall stature and robust branchlets of this species.

Notes. The epithet was proposed by K.A. Meney and K.W. Dixon while the former was working on her PhD on the ecology of Restionaceae and Cyperaceae based at Kings Park and Botanic Garden, but the name was never published.

Caustis gigas has affinities with *C. pentandra* R.Br., a species complex in great need of revision, spanning much of southern Australia and extending to south-east Queensland. *Caustis gigas* differs in the usually larger plants (to 2.5 *vs* to 1.2 m, occasionally to 2.5 m), thicker primary culms (2.2–5.0 *vs* 1.9–3.2 mm diam.), larger anthers (5.9–7.7 *vs* 5–6 mm long) and larger nuts (8.9–9.8 *vs* 4.5–8 mm long).

The vernacular name Giant Twigrush is suggested.

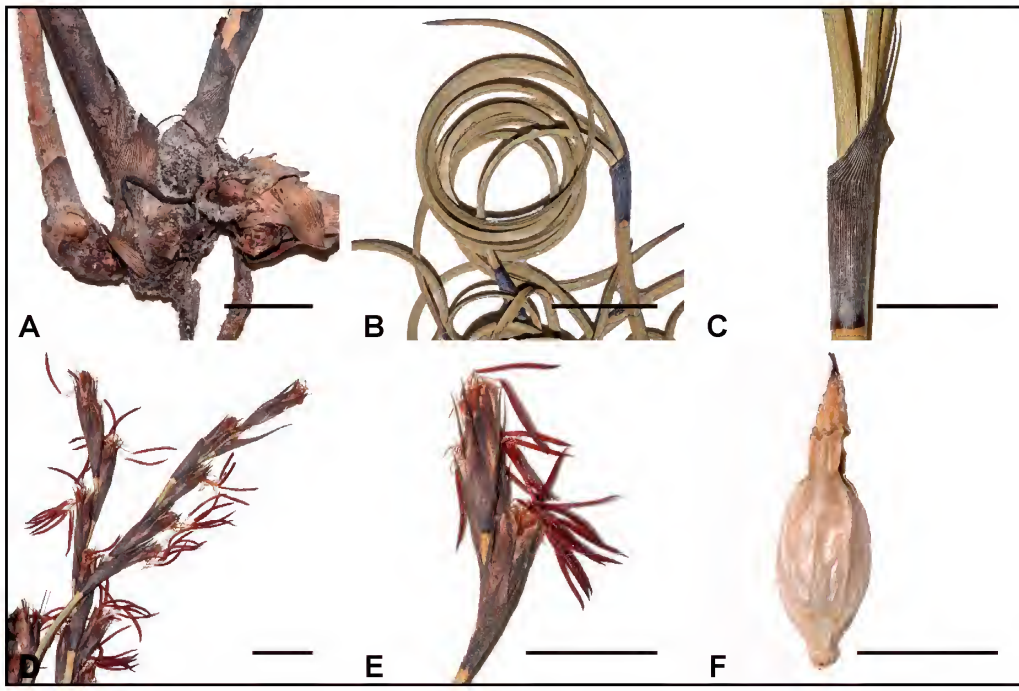

Figure 6. *Caustis gigas*. A – rhizome; B – distinctly curled terminal branchlets; C – leaf reduced to a sheathing bract with acuminate apiculum; D – inflorescence; E – spikelets and anthers; F – nut. Scale bars = 1 cm (A, B, D, E); 5 mm (C, F). Images from *A.S. George* 9318 (A–E) and *R.J. Cranfield & P.J. Spencer* 8001 (F). Photographs by R.L. Barrett.

Lepidosperma fairallianum R.L.Barrett, *sp. nov.*

Type: west base of Mount Ney at end of Mount Ney track and along western face, 40 km north of Condingup, Western Australia, 5 December 2005, *R.L. Barrett & M.D. Barrett* RLB 2985 (*holo*: PERTH 07304390; *iso*: NE, NSW).

Lepidosperma sp. Mt Burdett (M.A. Burgman & C. Layman MAB 3287), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Clump-forming, *tufted perennial*, forming compact clones 0.3–1.2 m across. *Rhizomes* 20–60 mm long, horizontal; *rhizome scales* dark brown, becoming fibrous with age, 6.4–9.2 mm long, 2.0–3.3 mm diam., often only loosely appressed to the rhizome, the apex subacute to obtuse. *Culms* and *leaves* distichous; leaf to culm length ratio 0.6–0.9:1; angle of fan (ramet) spread 8–15°. *Leaves* equitant, stiff, erect; *sheath* dark brown at the base, yellow below the blade, glabrous, the base not becoming fibrous with age, with a small amount of pale yellow, weakly aromatic resin; *blade* well-developed, very compressed, flat to slightly concavo-convex, finely ridged or striate with 28–44 stomatal columns per face, 16–47 cm tall, 2.2–3.6 mm wide, 0.4–0.8 mm thick, dull green to mid- or darkish green, not glaucous; margins acute, initially with very fine, white, erect hairs to 0.05 mm long (visible at 40×), with a fine coating of clear resin at the base. *Culms* similar to leaves, with 34–48 stomatal columns per face, 17–47(–75) cm tall, 2.5–3.7 mm wide, 0.5–0.7 mm thick; margins as for leaves. *Inflorescence* compact to shortly elongate, narrow, almost linear to narrowly ovate in outline, 30–100 mm long, 10–32 mm diam., with numerous very short branches, one branch per node; basal branch 12–43 mm long with 7–44 spikelets, spikelets held in tight clusters that give the inflorescence an interrupted appearance;

involucral bract 21–43(–57) mm long, about 1/2 the length of the inflorescence. *Spikelets* 4.1–6.9 mm long, the upper flower bisexual, the lower flower functionally male. *Glumes* 5–7, keeled, dark reddish brown, aging grey, grading to narrow, opaque margins which are slightly fimbriate towards the apex, the exposed surface around the keel evenly covered with short, appressed to ascending white hairs (glabrous below), the apex apiculate; sterile glumes 1–3; fertile glumes 3.7–5.5 mm long, 1.0–1.2 mm wide. *Hypogynous scales* 6, falling with the nut, narrow-triangular, white, 0.9–1.3 mm long; apex attenuate, with scattered short hairs clustered at the tip. *Stamens* 3; filaments 2.4–3.3 mm long; *anthers* 2.1–2.8 mm long, 0.3–0.4 mm diam. with an apical appendage 0.3–0.5 mm long. *Style* 3-fid, unbranched portion 1.2–1.7 mm long, branches 1.3–2.2 mm long with dense, minute hairs; base continuous with ovary, caducous; stylar cap small, shortly hairy. *Nut* obovoid, terete, smooth, with 3 distinct ribs, 2.4–2.7 mm long, 1.0–1.2 mm diam., pale brown; epidermal cells mostly narrow-oblong. (Figure 7)

Diagnostic characters. Distinguished from *L. congestum* R.Br. and *L. viscidum* R.Br. by the following combination of characters: *leaf* blades 2.2–3.6 mm wide, 0.4–0.8 mm thick, flat to slightly concavo-convex, with the margins acute, initially with very fine, white, erect hairs to 0.05 mm long (visible at 40×), with a fine coating of clear resin at the base; *inflorescence* compact, spikelets held in tight clusters that give the inflorescence an interrupted appearance; *stylar cap* small, shortly hairy.

Selected specimens examined (*c.* 80 seen). WESTERN AUSTRALIA: Mt Burdett Nature Reserve, *c.* 400 m W of Wittenoom Hills Rd on Norwood Rd, S road reserve, 8 June 2007, *E.D. Adams* 5/0807 (PERTH); gravel pit, 1.2 km N on Dempster Rd from Scaddan Rd on W side, 28 Oct. 2005, *R.L. Barrett & M.D. Barrett* RLB 2891 A (PERTH); Quoin Head track, 50 m along W fork near Quoin Head, Fitzgerald River National Park, 6 Dec. 2005, *R.L. Barrett & M.D. Barrett* RLB 2993 (PERTH); *c.* 3 km SE of Mt Arid, 6.5 km along Fisheries Rd from Poison Creek Rd, Cape Arid National Park, 22 Jan. 2008, *R.L. Barrett & M. Moody* RLB 4327 (BRI, K, NE, NSW, PERTH); small hill, 11.3 km from Bremer Bay–Borden Rd on Dillon Bay Rd, then Foster Beach track (old Minarup Rd), N of Mt Remarkable, *c.* 15 km W of Bremer Bay, 8 Feb. 2008, *R.L. Barrett & M. Moody* RLB 4424 (MEL, NE, NSW, PERTH); Mt Burdett, 1 Sep. 1984, *M.A. Burgman & C. Layman* MAB 3287 (PERTH); 9 km NNE of Mt Ney, 7 May 1983, *M.A. Burgman & S. McNee* MAB 1265 (CANB, PERTH); Mt Ney, 1 Oct. 1983, *M.A. Burgman & S. McNee* MAB 2541 (PERTH); Cheadanup Reserve, Munglinup, 17 Apr. 2007, *G. Byrne* 2642 (PERTH); Shoemaker Levy, Ravensthorpe Nickel Operations mine tenement, *c.* 30 km E of Ravensthorpe, 19 Nov. 2005, *O. Davies* 10595 (PERTH); West Point Rd, *c.* 25 km NW of Cascade [Plot - GP01], 13 Oct. 2000, *G.J. Keighery & N. Gibson* 5519 (PERTH); Ravensthorpe Range, survey site R081, 19.1 km ESE of Ravensthorpe, 23 May 2007, *S. Kern, R. Jasper & D. Brassington* LCH 16930 (PERTH); Ravensthorpe Range, survey site R125, 9.0 km NNW of Ravensthorpe, 6 Sep. 2007, *S. Kern, R. Jasper & H. Hughes* LCH 17356 (PERTH); Mason Bay Rd, Ravensthorpe, 19 May 2005, *K. Mappin* 10816 (PERTH); 11 km S of Reynolds Hill, 29 Apr. 1974, *K.R. Newbey* 4112 (PERTH); 7 km E of Ellen Peak, 15 Apr. 1975, *K.R. Newbey* 4702 (PERTH); Belinup Hill, Cape Arid National Park, 7 Nov. 1980, *K.R. Newbey* 7896 (PERTH).

Phenology. Flowering from April to May. Fruiting from July to October.

Distribution and habitat. Relatively widespread along the south coast of Western Australia, from Albany to Cape Arid. Grows in a range of habitats, on sandy loam with laterite, ironstone gravel, clayey sand, shallow sandy soil over granite or limestone to sandy silcrete. Found on upland flats, granite rock margins and slopes, and on open plains. Found in association with *Acacia mutabilis*, *Allocasuarina humilis*, *Baeckea crassifolia*, *Banksia cirsioides*, *B. lemanniana*, *B. media*, *Boronia inornata*, *Calothamnus pinifolius*, *Eucalyptus brachycalyx*, *E. falcata*, *E. incrassata*, *E. indurata*, *E. pluricaulis*, *E. varia*, *Gahnia ancistrophylla*, *G.* sp. aff. *lanigera*, *Melaleuca pentagona*, *M. rigidifolia* and *Tetrapora verrucosa*.

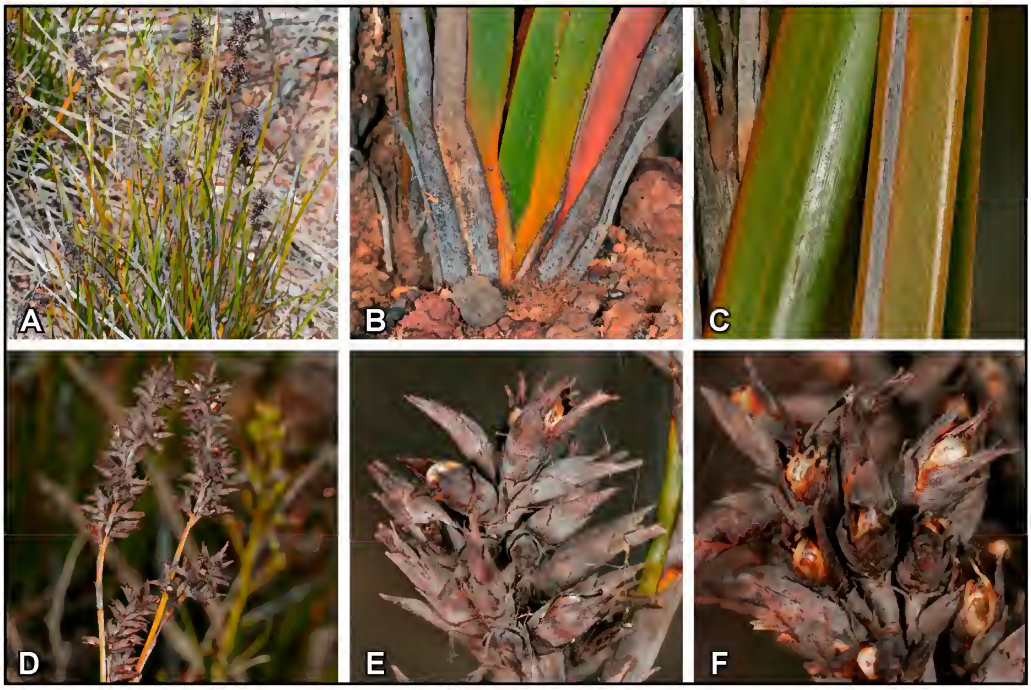

Figure 7. *Lepidosperma fairallianum*. A – habit; B – base of ramet; C – leaves; D – inflorescence; E – clustered spikelets; F – fruiting spikelets. Images from *R.L. Barrett* RLB 3480. Photographs by R.L. Barrett.

Conservation status. *Lepidosperma fairallianum* is widespread and is not considered threatened.

Etymology. The epithet honours Arthur Fairall (1920–1970), Kings Park Superintendent (1962–1970), and Pauline Fairall (*née* Bond, 1935–2010), Kings Park Herbarium Botanist (1963–1973, 1995–2003), for their efforts in botanical collecting and commitment to the work of Kings Park and Botanic Garden.

Notes. The closest relative of *L. fairallianum* was not strongly resolved by Barrett (2012b); however, a weak relationship with *L. congestum* and *L. viscidum* was suggested. Morphologically, *L. fairallianum* is possibly most similar to *L. congestum* with which it shares a condensed inflorescence, but the former differs in having darkly coloured spikelets arranged in distinct clusters (*vs* mid-brown spikelets that are condensed, but not clustered), a rather short, squat habit (*vs* erect, slender habit), and culms and leaves with yellowish bases with a small amount of clear resin (*vs* clums and leaves with green bases and plentiful resin).

The vernacular name Fairalls' Sword Sedge is suggested.

Lepidosperma hopperi R.L.Barrett, *sp. nov.*

Type: on south side of walk trail from Mount Le Grand to Hellfire Bay, Cape Le Grand National Park, Western Australia, 22 January 2008, *R.L. Barrett & M. Moody* RLB 4317 (*holo*: PERTH 08614105; *iso*: BRI, MEL, NE, NSW, PERTH).

Clump-forming, *tufted perennial*, forming large, dense clones to about 5 m across. *Rhizomes* 50–300 mm long, horizontal; *rhizome scales* mid-brown to dark brown to almost black, darkest towards the soil

surface, not becoming fibrous with age, 8.3–11.5 mm long, 1.7–3.1 mm diam., closely appressed to the rhizome, the apex subacute to acute. *Culms* and *leaves* distichous; leaf to culm length ratio 0.8–0.9(–1):1; angle of fan (ramet) spread 20–40°. *Leaves* equitant, stiff, erect; *sheath* pale brown when light-exposed, dark brown to black below ground level, glabrous except for scattered hairs on margins, the base not becoming fibrous with age, with pale yellow resin having a weak citronella scent; *blade* well-developed, very compressed, flat to slightly concavo-convex, finely ridged or striate with 30–52 stomatal columns per face, 45–210(–300) cm tall, 7–14 mm wide, 0.5–0.8 mm thick, dull green to yellow-green, not glaucous; margins acute, reddish to semi-translucent with a continuous band of very fine erect hairs to 0.2 mm long, the hair bases often matted together with red resin (glabrescent on older growth). *Culms* similar to leaves, with 28–62 stomatal columns per face, 50–220(–300) cm tall, 8–16 mm wide, 1.2–1.8 mm thick; margins as for leaves. *Inflorescence* slender, elongate, ±lanceolate in outline (almost linear when young), 90–160 mm long, 24–48 mm diam., with numerous long branches, some of these with short secondary branches, one lateral branch per node; basal lateral branch 40–85 mm long with 35–68 spikelets; involucral bract 45–110 mm long, at least 1/2 as long as inflorescence. *Spikelets* 5.7–7.3 mm long, the upper flower bisexual, the lower flower functionally male. *Glumes* 5(–7), keeled, grey-brown to straw brown, grading to reddish brown towards the apex and with narrow, opaque, entire margins, the exposed surface around the keel evenly and densely covered with short, appressed to ascending white hairs (glabrous below), the apex acute to apiculate; sterile glumes 1(–3); fertile glumes 4.7–6.4 mm long, 1.3–1.6 mm wide. *Hypogynous scales* 6, falling with the nut, very narrowly triangular to subulate, white, 1.3–1.7 mm long; apex long-attenuate, with scattered short hairs in apical 1/3. *Stamens* 3; filaments 2.4–3.4 mm long; *anthers* 2.8–3.1 mm long, 0.3–0.4 mm diam. with an apical appendage 0.3–0.5 mm long. *Style* 3-fid, unbranched portion 1.9–2.1 mm long, branches 2.2–2.4 mm long with sparse, minute hairs; base continuous with ovary, caducous; stylar cap large, glabrous. *Nut* obovoid, terete, smooth, with 3 distinct ribs and sometimes with another 3 slender ribs between those, 3.1–3.3 mm long, 1.3–1.5 mm diam., pale brown; epidermal cells ±oblong. (Figure 8)

Diagnostic characters. Distinguished from *L. drummondii* Benth. by the following combination of characters: robust, clonal *perennial* sedge with leaves and culms to 2.2(–3) m tall; *leaf blades* 7–14 mm wide, 0.5–0.8 mm thick, resinous, dull green to yellow-green with a reddish to semi-translucent margin with a continuous band of very fine erect hairs to 0.2 mm long; *inflorescence* slender, elongate, ±lanceolate in outline; *spikelets* 5.7–7.3 mm long; *hypogynous scales* very narrowly triangular to subulate, 1.3–1.7 mm long, long-attenuate, with scattered short hairs in apical 1/3.

Selected specimens examined (*c.* 40 seen). WESTERN AUSTRALIA: Mt Clarence, 29 Aug. 1902, *C. Andrews s.n.* (PERTH); Mt Clarence, Albany, Jan. 1903, *C. Andrews s.n.* (PERTH); Possession Point, S of Albany, Torndirrup Peninsula, near lookout on point, 22 Mar. 2006, *R.L. Barrett* RLB 3340 (K, NSW, PERTH); lower slopes on mountain, on walk trail to summit (off Mt Lindesay Road), Mt Lindesay, Mt Lindesay National Park, N of Denmark, 21 June 2007, *R.L. Barrett & M. Wallace* RLB 4085 (AD, BRI, CANB, K, MEL, NE, NSW, PERTH); Mt Lindesay, Denmark, 17 Feb. 1995, *S. Barrett* 298 (PERTH); Mt Elphinstone, Albany, 13 Aug. 1996, *M.E. Nash* 2 (PERTH); Mt Elphinstone, Albany, 27 May 2000, *M.E. Nash* MEN 64 (PERTH); Bremer Bay, 30 Jan. 1972, *K. Newbey* 3526 (PERTH); Mt Clarence, Albany, 25 Apr. 1975, *K. Newbey* 4720 (NSW, PERTH).

Phenology. Flowering from April to May. Fruiting from August to October.

Distribution and habitat. Widespread and common on large granite domes in the southern forests and along the south coast of Western Australia, from Muirillup Rock (east of Northcliffe) and Winnejup (south-east of Bridgetown) in the west, through Walpole, Mt Frankland, Mt Lindesay and the Porongurup

Figure 8. *Lepidosperma hopperi*. A – Steve Hopper in habitat with *L. hopperi* on Little Mt Lindesay; B – habitat in the Porongurup Range; C – habit on Mt Lindesay; D – Steve Hopper in habitat with *L. hopperi* on Chettenjacke rock, *c.* 3 km SE of the summit of Yorlinning (Mt Arid). Middle Island lies 10 km SSW offshore in the background; E – habit on Little Mt Lindesay; F – base of a young plant in granite fissure; G – tussock resprounting after fire in the Porongurup Range; H – budding inflorescence; I – infructescence. Images from *R.L. Barrett & M. Wallace* RLB 4085 (C, F, H, I; others not vouchered). Photographs by R.L. Barrett (A–C, E–I); D. Reynolds (D).

Range, with a considerable disjunction then eastward to the Esperance–Cape Arid National Park coastal region. Particularly common on granite domes around Albany and Esperance. Grows as large tussocks on shallow soil on granite, often forming dense fringes to rock domes, growing with *Acacia conniana*, *A. heteroclita*, *A. myrtifolia*, *A. subcaerulea*, *Andersonia sprengelioides*, *Borya nitida*, *B. longiscapa*, *Calothamnus quadrifidus*, *Drosera* spp., *Eutaxia myrtifolia*, *Grevillea fuscolutea*, *Hakea clavata*, *H. drupacea*, *Lepidosperma* spp., *Leptospermum sericeum*, *Platysace compressa*, *Stypandra glauca*, *Taxandria callistachys*, *T. marginata* and *Trachymene caerulea*.

Conservation status. *Lepidosperma hopperi* is locally common and not currently threatened.

Etymology. The epithet honours the work of Stephen Donald Hopper, former Research Officer (Flora Conservation) with the Department of Fisheries and Wildlife, former Research Scientist with the Department of Conservation and Land Management, former Chief Executive Officer of the Botanic Gardens and Parks Authority, former Director (CEO and Chief Scientist) of the Royal Botanic Gardens, Kew, and now Professor of Biodiversity at The University of Western Australia. The choice of this species, characteristic of granite rocks, commemorates a career researching granite rock habitats in southern Western Australia and around the world, and the collection of many unusual sedge species.

Notes. Previously, *L. hopperi* has been confused with *L. drummondii*, a species of sandy and laterite plains that is also found in the Albany area. *Lepidosperma drummondii* and *L. hopperi* were both included in the original concept of *L. drummondii* by Bentham (1867; see Barrett & Wilson 2012) due to superficial similarities. Unlike *L. drummondii*, *L. hopperi* has a finer inflorescence, finer hairs and less resin on the leaf and culm margins, yellowish (*vs* dark green) leaves and culms, and a preference for granitic habitats (*vs* laterite or sand over laterite or clay). This taxon has for some years been known informally as *L.* sp. 'Southern Granite'.

Genetic data support *L. hopperi* as sister to the morphologically dissimilar (fine, terete to semi-terete culms) but geographically sympatric *L. gracile* R.Br. species complex, while *L. drummondii* is related to *L. ustulatum* Steud. (Barrett 2012b).

Lepidosperma hopperi has also been widely confused with the similarly robust *L. effusum* Benth., which differs in having dark green culms and leaves with glabrous margins, a very elongated inflorescence and a preference for swampy, riverine or wet forest habitats (sometimes growing at the base of granite rocks in forests).

The vernacular name Hopper's Sword Sedge is suggested.

Lepidosperma oldhamii R.L.Barrett, *sp. nov.*

Type: Kings Park bushland, near Eucalyptus Carpark, West Perth, Western Australia, 26 June 2014, *R.L. Barrett* RLB 9055 (*holo*: PERTH 08613893; *iso*: CANB, K, MEL, NE, NSW).

Clump-forming, *tufted perennial*, forming compact clones to *c.* 0.5 m across. *Rhizomes* 40–120 mm long, horizontal; *rhizome scales* dark brown to almost black, grading to grey-brown at the soil surface, becoming fibrous with age, 4.2–9.0 mm long, 1.6–2.4 mm diam., closely appressed to the rhizome, the apex acute. *Culms* and *leaves* distichous; leaf to culm length ratio 0.9–1.1:1; angle of fan (ramet) spread 8–15°. *Leaves* equitant, wiry, erect; *sheath* pale brown to dark brown, glabrous, the base becoming somewhat fibrous with age, lacking obvious resin; *blade* well-developed, very compressed, thinly biconvex, very finely ridged or striate with 12–16 stomatal columns per face, 26–59 cm tall, 1.2–1.9 mm wide, 0.4–0.6 mm thick, mid-green to dark green, not glaucous; margins acute, smooth, lacking obvious resin. *Culms* similar to leaves but more angular in section, with 36–40 stomatal columns per face, 55–80 cm tall, 2.0–2.9 mm wide, 0.8–1.4 mm thick; margins as for leaves. *Inflorescence* compact, usually held oblique to the culm axis, becoming reflexed with age, narrowly ovate to ±oblong in outline, 45–80 mm long, 12–27 mm diam.; primary axis with 4–7 short branches, occasionally some primary branches with a single secondary branch, one lateral branch per node; basal lateral branch 19–41 mm long with 14–37 spikelets in well-spaced, compact clusters; involucral bract (34–)46–80 mm long, usually just exceeding the inflorescence. *Spikelets* densely arranged, 5.4–7.3 mm long, the upper flower bisexual, the lower flower functionally male. *Glumes*

7–9, keeled, dark brown, grading to dark reddish brown towards the margins with narrow, opaque margins, the exposed surface around the keel with short, appressed or ascending white hairs, often concentrated along the nerves and margins (glabrous below), the apex acute to apiculate; sterile glumes 3–5; fertile glumes 5.9–7.6 mm long, 1.4–2.0 mm wide. *Hypogynous scales* 6, falling with the nut, narrow-triangular, white, 0.8–1.5 mm long; apex acute to attenuate, with a few short hairs. *Stamens* 3; filaments 2.8–4.2 mm long; *anthers* 2.8–3.2 mm long, 0.35–0.55 mm diam. with an apical appendage 0.4–0.5 mm long. *Style* 3-fid, unbranched portion 1.6–2.3 mm long, glabrous, branches 1.2–1.8 mm long with scattered, minute hairs; base continuous with ovary, caducous; stylar cap small, glabrous. *Nut* obovoid, terete, smooth, with 3 indistinct ribs, 3.2–3.5 mm long, 1.3–1.5 mm diam., pale brown to reddish brown; epidermal cells indistinct, ±round to oblong. (Figure 9)

Diagnostic characters. Distinguished from both *L. squamatum* Labill. and *L. calcicola* R.L.Barrett & K.L.Wilson by the following combination of characters: *leaves* slender; *sheath* pale to dark brown, becoming fibrous with age; *blade* biconvex, 1.2–1.9 mm wide, 0.4–0.6 mm thick; *culms* 2.0–2.9 mm wide, 0.8–1.4 thick; *inflorescence* with well-spaced, compact clusters of spikelets.

Other specimens examined. WESTERN AUSTRALIA: Forrest Rd, Bibra Lake, Oct. 1979, *P. Bridgewater s.n.* (PERTH); private property, 2.7 km from coast on track between Deeside Coast Rd and the coast (Plot: dcr4), 5 May 1991, *N. Gibson & M. Lyons* 639 (PERTH); Gazetted Reserve 2471, Trigg Dunes Reserve, Trigg, 20 km N of Perth, 13 Nov. 1989, *G.J. Keighery* 10876 (PERTH).

Phenology. Flowering usually in May. Fruit mature from September to October.

Distribution and habitat. Probably common and relatively widespread on the Swan Coastal Plain in south-western Australia, but only a few collections from the Perth metropolitan area are currently assigned to this species. Grows on white to grey sands in woodland associated with *Acacia pulchella*, *Allocasuarina fraseri*, *A. humilis*, *Banksia attenuata*, *B. menziesii*, *Eucalyptus gomphocephala*, *Hypocalymma robustum*, *Levenhookia pusilla*, *Mesomelaena pseudostygia*, *Philotheca spicata*, *Pithocarpa cordata*, *Xanthorrhoea brunonis* and *X. preissii*.

Conservation status. *Lepidosperma oldhamii* appears to be relatively widespread on the Swan Coastal Plain in the south-west of Western Australia and is not currently considered threatened. It is, however, poorly collected and impacted by urbanisation, and further surveys and study are required to accurately determine its distribution.

Etymology. The epithet recognises the work of John Oldham (1907–1999), landscape architect for the City of Perth, who drew up some of the original landscaping plans that influenced the design of the Western Australian Botanic Garden at Kings Park, along with many other well-known features of the capital city, including the Swan River foreshore, the Narrows Interchange, Sir Charles Gairdner Hospital and Parliament House.

Notes. This species has been previously confused with *L. squamatum*, a name that has in the past been applied to a large number of distinct taxa but is correctly applied to a species from coastal areas between Esperance and Cape Arid (see Barrett 2012a for a description and discussion). *Lepidosperma oldhamii* has glabrous leaf and culm margins while *L. squamatum* has small, short, thick, white hairs that become reduced to small, scabrid projections on the margins. *Lepidosperma oldhamii* is similar in appearance to *L. calcicola* (see Barrett & Wilson 2013) with which it occasionally grows in Kings Park; however, it is not closely related to *L. calcicola*, differing in its taller stature, thicker, more rounded

leaves, denser culms, and a more robust inflorescence which is held obliquely, becoming reflexed with age. In *L. oldhamii*, the unbranched portion of the style is 1.6–2.3 mm long (*vs* 3.5–4.3 mm long in *L. calcicola*) and the nuts are 3.2–3.5 mm long (*vs* 2.3–2.5 mm long).

With the correct application of the name *L. squamatum*, a large clade of taxa previously referred to that name has been left with no named taxa (Barrett 2012b). While species boundaries in this difficult complex will need considerable work to be defined adequately, *L. oldhamii* is named here so the clade can be referred to using a validly named species.

The vernacular name Oldham's Sword Sedge is suggested.

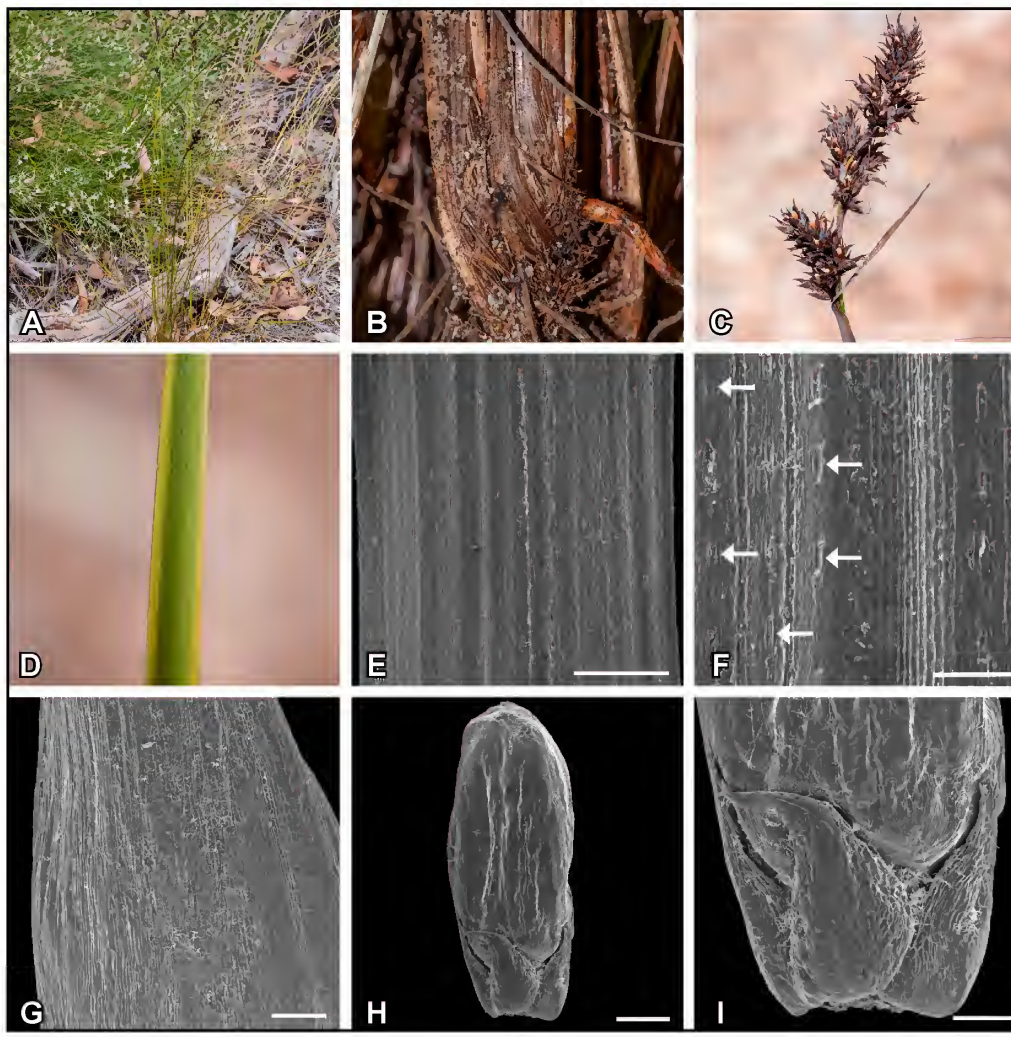

Figure 9. *Lepidosperma oldhamii*. A – habit; B – base of leaf sheaths; C – inflorescence; D – culm showing convex face; E – SEM of dry leaf face with gentle undulations; F – SEM showing stomatal columns on leaf face (arrowed); G – SEM of middle part of fertile glume; H – SEM of nut; I – SEM of hypogynous scales, with minute hairs visible at apices. Scale bars = 500 μm (E, H); 100 μm (F); 200 μm (G, I). Images from *R.L. Barrett* RLB 9055. Photographs by R.L. Barrett.

Schoenus thedae M.D.Barrett & R.L.Barrett, *sp. nov.*

Type: Theda Station, Western Australia [precise locality withheld for conservation reasons], 10 March 2014, *R.L. Barrett* RLB 8891 (*holo*: PERTH 08613974; *iso*: CANB, K).

Schoenus sp. Theda (M.D. Barrett 1578 B), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Annual caespitose herb 40–150 mm high, glabrous on all parts except glume keels; roots pinkish red. *Culms* 3–9 per plant, without nodes, slender, 0.3–0.4 mm wide, when dry irregularly ribbed, ridged or angled, sometimes almost 4-angled or flattened. *Leaves* sheathing; *sheath* closed, 4–10 mm long, membranous to weakly few-ribbed, pale translucent green to straw-coloured; *blade* 7–70 mm long, 0.3–0.6 mm wide, channelled on adaxial surface; *ligule* a thickened ridge of tissue *c.* 0.05 mm high. *Bracts* erect, with a green to reddish sheath 3–7 mm long and slender, leaf-like blade (3–)6–25 mm long. *Inflorescence* 18–50 mm long, 15–30 mm wide, with 2–8 long-pedunculate solitary spikelets per culm; peduncles in 1–3 (usually 2) clusters or levels, each subtended by a bract, peduncles 4–26(–52) mm long, ±filiform. *Spikelets* narrowly lanceolate to narrowly oblong, compressed, (5.5–)7.0–15.0 mm long, (1.2–)1.5–3.5 mm wide, 3–8-flowered, with 2 or 3 empty basal glumes; flowers sub-distichous; rachis 2–3 mm long, flattened and curved around each nut at maturity. *Basal sterile glumes* 2 or 3, broadly ovate to ovate, 1.6–3.5 mm long, keeled, apex acute. *Floral glumes* 3–6 (frequently 4), moderately narrowly ovate, 5.5–7.5 mm long, keeled, lacking nerves or with 1 obscure nerve on each side close to midrib, green or chestnut and minutely scabrous along midrib; apex muticous; margins membranous and streaked reddish, sometimes also flushed chestnut, entire. *Perianth segments* 6, in 2 whorls of 3, not reduced. *Outer perianth segments* greatly exceeding the nut, 2.7–3.1 mm long, white, shed with the nut; distal 1/2 awn-like, glabrous but minutely antrorsely scabrous; basal part slightly shorter than nut, broader than awns (very narrowly lanceolate or thickly sub-terete) and with dense, fine, appressed to slightly ascending antrorse hairs over whole surface. *Inner perianth segments* alternating with and similar to outer segments but longer (3–4 mm long); basal part more distinctly flattened and broader (*c.* 0.15 mm wide), with a dark straw-coloured, very shortly hairy midline and paler, densely hairy margins. *Stamens* 3; *anthers* 3.0–3.8 mm long, yellow, minutely apiculate at apex, lacking basal or apical hairs. *Style* slender, terete, not expanded at base, not articulate, 3.5–4.5 mm long in undivided portion, with 3 stigmatic branches 1.0–1.5 mm long. *Nut* on a stipe *c.* 0.2 mm long, trigonous-obovoid and shortly beaked, 1.0–1.1 mm long (excluding beak), 0.7–0.8 mm diam., cream- to straw-coloured at maturity, strongly 3-ridged, sub-glossy and smooth between ribs, with *c.* 10 rows of moderate-sized, obscure to weakly visible cells on each surface (discernible only at full maturity); ribs projecting at apical margins into a slight to prominent wing or thickened horn *c.* 0.1–0.4 mm high and smoothly rounded or projecting upward at outer margin, so that nut apex is weakly to very strongly 3-lobed, otherwise almost truncate; beak *c.* 0.2–0.3(–0.8) mm long, slender. (Figure 10)

Diagnostic characters. Distinguished from all tropical Australian species of *Schoenus* L. by the following combination of characters: annual *herb*; *inflorescence* few-noded, open; *spikelets* pedunculate, compressed, solitary; *perianth* not reduced, hairy, of 6 bristles longer than the nut; *nut* beaked, 1.0–1.1 mm long, 0.7–0.8 mm diam., strongly 3-ridged.

Other specimens examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 17 Feb. 2005, *M.D. Barrett* MDB 1578 B (PERTH); 17 Mar. 2011, *M.D. Barrett* MDB 3360 (PERTH); 28 Apr. 2008, *M.D. Barrett & R.L. Barrett* MDB 2147 (BM, BRI, MEL, NE, NSW, PERTH).

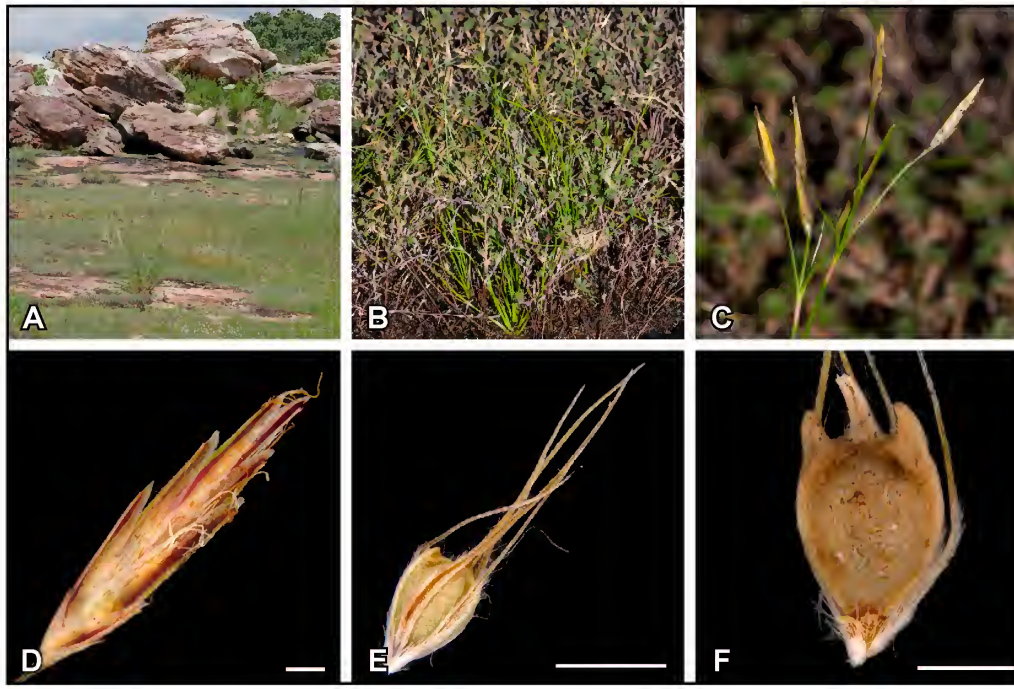

Figure 10. *Schoenus thedae*. A – habitat of thin sand sheet over massive sandstone pavement; B – habit; C – inflorescence; D – spikelet; E – nut and hypogynous bristles; F – nut and bristles. Scale bars = 1 mm (D, E); 500 μm (F). Images from *R.L. Barrett* RLB 8891. Photographs by R.L. Barrett (A–C); M.D. Barrett (D–F).

Phenology. Flowering and fruiting recorded from January to March.

Distribution and habitat. Known only from a single location on Theda Station in the central North Kimberley where it grows on seasonally wet skeletal sands on a sandstone pavement which dries up rapidly when rains cease at the end of the wet season (about April). Grows with *Drosera cucullata*, *Eriocaulon scullionii*, *Micraira brevis*, *M. dunlopii* and *Rhynchospora* sp. Arnhem (P.K. Latz 2999).

Conservation status. *Schoenus thedae* is listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *S.* sp. Theda (M.D. Barrett 1578 B). *Schoenus thedae* is currently known from only a single population despite having been subject to extensive wet season surveys between 2001 and 2014. Although the pavement it grows on is relatively large (*c.* 1 km across), the population appears restricted to an area *c.* 20 m across and is estimated to contain *c.* 500 plants.

Etymology. The epithet is derived from the name of the station where this species is found. Theda Station was apparently named for Theda, the wife of the founder of the station lease, hence the feminine gender.

Notes. *Schoenus thedae* differs from most other tropical Australian *Schoenus* species in being a small annual (*vs* robust perennials), with a few-noded, open inflorescence and having a non-reduced, hairy perianth of six bristles longer than the nut. *Schoenus yarrabensis* Domin, from Queensland, can also be an annual, but differs in being more robust (and sometimes perennial) and in having perianth segments more or less equal in length. *Schoenus thedae* does not appear to be closely related to any known taxon with molecular data placing it in an isolated, but unsupported, position in a detailed

phylogeny of the genus (A. Gibbs *et al.*, unpubl. data). It is most similar morphologically to *S. badius* Rye and *S. pennisetis* S.T.Blake (both endemic in south-western Australia; Rye 1997a). In a key to Western Australian annual Cyperaceae (Rye 1997b), *S. thedae* would key to *S. pennisetis*, but differs from this species in having perianth lobes long-awned and greatly exceeding the nut (*vs* as long as or shortly exceeding the nut in *S. pennisetis*; Blake 1949), the nut apex truncate or 3-lobed (*vs* acute in *S. pennisetis*), and longer spikelets (5.5–)7.0–15.0 mm long (*vs* 4–5 mm long in *S. pennisetis*). Of the eastern Australian annual *Schoenus* species, *S. thedae* appears to be most similar to *S. apogon* Roem. & Schult. and *S. paludosus* (R.Br.) Poir., differing in the perianth greatly exceeding the nut (subequal or shorter than the nut in the two south-east species), and in usually having longer peduncles. *Schoenus thedae* is also similar to *S. latelaminatus* Kük. from south-eastern Australia and *S. centralis* Latz from central Australia, species which differ in lacking or having a minute perianth, and having reticulate-pitted and acute nuts.

The vernacular name Kimberley Pavement Sedge is suggested.

Dasypogonaceae

Calectasia demarzii R.L.Barrett, *sp. nov.*

Type: south-west of Wellstead, 1.1 km west on Mettler Road from Sandalwood Road, Western Australia, 4 October 1999, *R.L. Barrett, K.W. Dixon & M.D. Barrett* RLB 1348 (*holo*: PERTH 05542510; *iso*: AD 124526, BM, CANB 550057, KPBG, L, MEL 2290834, NSW, UWA).

Calectasia grandiflora (South Coast variant), R.L. Barrett & K.W. Dixon, *Nuytsia* 13: 427, Figure 7D–G (2001).

Calectasia grandiflora subsp. southern (H. Demarz 546), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Clonal perennial; *rhizome* short, 'looping', with sand-binding roots. *Stems* to 35 cm high, with many short lateral branches usually crowded at the apex. *Leaves*: *sheath* with short, branched trichomes on margin, glabrous otherwise; *lamina* 5.2–13.0 mm long, 0.4–0.6 mm wide, glabrous; margins finely scabrous; apex acute with a mucro 0.3 mm long. *Bracts* 9.6–11.2 mm long, 1.3–2.5 mm wide, papery, white to pale brown with a pale brown apex; outer bracts reddish brown; margins pilose; apex with green vestigial leaf lamina 1.5–2.5 mm long, 0.4–0.5 mm wide. *Perianth* tube 9.4–10.2 mm long, pilose in lower 1/5, not prominently costate when dry; lobes 12.8–16.5 mm long, 2.6–4.7 mm wide, acuminate, blue-red fading to pale blue-red, pilose on abaxial side; margins opaque; throat with tangle of short, barbed hairs. *Staminal filaments* 2.8–3.7 mm long. *Anthers* 4.1–5.8 mm long, 0.7–1.2 mm diam., 3 slightly shorter, yellow, not turning orange-red with age; pores terminal. *Style* 12.5–13.8 mm long, exceeding anthers. *Seeds* not seen. (Figure 11)

Diagnostic characters. Distinguished from *C. grandiflora* L.Preiss by the following combination of characters: *rhizome* spreading, 'looping'; *leaf blades* 5.2–13.0 mm long, 0.4–0.6 mm wide; *perianth* tube 9.4–10.2 mm long, pilose in lower 1/5; *perianth* lobes 12.8–16.5 mm long, 2.6–4.7 mm wide, blue-red fading to pale blue-red; *anthers* 4.1–5.8 mm long, yellow.

Selected specimens examined (*c.* 40 seen). WESTERN AUSTRALIA: junction of Rocky Crossing Rd and Willyung Rd, N of Albany, 30 Nov. 1965, *J.C. Anway* 253 (PERTH); 0.8 km into Stirling Range

National Park on Chester Pass Rd, 4 Oct. 1999, *R.L. Barrett, K.W. Dixon & M.D. Barrett* RLB 1351 (K, KPBG, NSW, PERTH); Red Gum Pass, Stirling Range National Park, 15 Sep. 1965, *A.C. Beauglehole* ACB 12945 (PERTH); 50 km NNE of Albany on Chester Pass Rd, 27 Sep. 2004, *R.K. Brummitt* 21375, *A.S. George & E.G.H. Oliver* (PERTH); Hunton Rd, off Nanarup Rd, E of Albany, 1 Sep. 1984, *E.J. Croxford* 3593 (PERTH); Mt Josephine, Stirling Range, 9 Oct. 1962, *A.R. Fairall* 485 (KPBG, PERTH); Mount Barker hill, 1 Nov. 1995, *T.R. Lally* 850 (CANB, PERTH); Tick Flat, Two Peoples Bay Nature Reserve, 5 Oct. 1972, *G.T. Smith & L.A. Moore s.n.* (PERTH); Scenic Drive, Porongurup National Park, 18 Oct. 1999, *J.R. Wheeler* 4014 (PERTH).

Phenology. Flowering and fruiting from October to November.

Distribution and habitat. Restricted to a small area in south-western Australia between Cape Riche, the Stirling Range and Walpole, with possible outlying populations near Dunsborough requiring further study. Grows in sparse woodland in sand with *Agonis*, *Allocasuarina* or *Eucalyptus* spp., often near granite outcrops and in open kwongan with low Proteaceae and Myrtaceae heath.

Conservation status. Widespread in several national parks and nature reserves and not considered threatened.

Etymology. The epithet recognises the work of Herbert Demarz, seed collector for Kings Park and Botanic Garden from 1970–1990. Demarz was also a prolific collector of insects, with several species having been named in his honour.

Notes. *Calectasia demarzii* was previously included in a broad concept of *C. grandiflora* (Barrett & Dixon 2001) and later given a phrase name at subspecific rank under that species. Following additional fieldwork, species rank is considered appropriate as the ranges of these taxa do not overlap and no intergrades are known. *Calectasia demarzii* can be distinguished from *C. grandiflora* by its smaller habit (stems to 35 cm *vs* to 60 cm), with spreading, 'looping' rhizomes (*vs* relatively compact, non-looping rhizomes), and slender leaf blades 0.4–0.6 mm wide (*vs* 0.8–1.2 mm wide).

The vernacular name Demarz's Tinsel Lily is suggested.

Calectasia elegans R.L.Barrett, *sp. nov.*

Type: Pinjar [north of Perth], Western Australia [precise locality withheld for conservation reasons], 8 November 2005, *C. Tauss* 557 (*holo*: PERTH 07215363).

Calectasia sp. Pinjar (C. Tauss 557), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Clonal perennial, with stilt roots to 8 cm long; *rhizome* absent. *Stems* to 45 cm high, with many short lateral branches. *Leaves*: *sheath* with short, branching trichomes on margin and a line of long, stiff hairs near the margin, otherwise glabrous; *lamina* 5.0–8.8 mm long, 0.38–0.53 mm wide, glabrous; margins scabrous at apex, otherwise glabrous; apex with a pungent mucro 0.2–0.5 mm long. *Bracts* 6.2–7.2 mm long, 1.4–2.4 mm wide, papery, translucent and off-white to opaque and pale brown; outer bracts similar; margins with unbranched or shortly branched trichomes, these sometimes also on midrib below apex; apex with green vestigial leaf lamina 1.4–2.0 mm long, 0.3–0.4 mm wide. *Perianth* tube 6.5–7.3 mm long, shortly pilose in lower 1/2 with 4 lines of hairs continuing for entire

length, prominently costate when dry; lobes 6.9–7.9 mm long, 1.8–2.2 mm wide, acute, blue, not becoming red with age, shortly pilose on abaxial side; margins opaque; throat glabrous above sinus with short hairs inside. *Staminal filaments* 2.1–2.3 mm long. *Anthers* 4.2–4.4 mm long, 0.90–0.95 mm diam., yellow turning orange-red with age; pores terminal. *Style* 6.0–7.7 mm long, exceeding anthers. *Seeds* not seen. (Figure 12)

Diagnostic characters. Distinguished from all other species by the following combination of characters: *undershrub* with stilt roots; *leaf blades* 5.0–8.8 mm long, 0.38–0.53 mm wide, glabrous; *perianth* tube 6.5–7.3 mm long, shortly pilose in lower 1/2 with 4 lines of hairs continuing for entire length, prominently costate when dry; *perianth* lobes 6.9–7.9 mm long, 1.8–2.2 mm wide, not aging red; *anthers* 4.2–4.4 mm long, turning orange-red with age.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 11 Dec. 2008, *B. Fellows & J. Waud* BCF 10 (K, PERTH); 16 Sep. 2008, *M.E. Hoskins* 13 *& L.W. Sage* (CANB, PERTH); 16 Sep. 2008, *M.E. Hoskins* 14 *& L.W. Sage* (MEL, PERTH); 28 Oct. 2008, *M.E. Hoskins & L.W. Sage* 2854 (PERTH); 11 Sep. 2008, *D. Mickle* 117 (PERTH); 11 Sep. 2008, *D. Mickle* 118 (PERTH).

Phenology. Flowering recorded for November (probably also flowering in earlier months).

Distribution and habitat. Known only from a few locations from the northern outskirts of the Perth Metropolitan Region between Pinjar and Bullsbrook on deep, grey, quartz sand in habitats that have experienced infrequent fires. Recorded growing in *Banksia menziesii* and *B. attenuata* woodland in association with *Adenanthos cygnorum*, *Alexgeorgea nitens*, *Andersonia heterophylla*, *Austrostipa compressa*, *Beaufortia elegans*, *Calothamnus sanguineus*, *Calytrix flavescens*, *Desmocladus flexuosus*, *Eremaea pauciflora*, *Hensmania turbinata*, *Hibbertia aurea*, *H. sericosepala*, *Jacksonia floribunda*, *Lechenaultia floribunda*, *Leucopogon conostephioides*, *Melaleuca seriata*, *Nuytsia floribunda*, *Patersonia occidentalis*, *Phlebocarya ciliata*, *Thysanotus thyrsoideus* and *Verticordia nitens*.

Conservation status. *Calectasia elegans* is listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *C.* sp. Pinjar (C. Tauss 557). It is an apparently rare species, known only from four very small populations, one on State-owned land, one in a nature reserve and two in a State forest reserve. Targeted survey is required to ascertain whether this species warrants listing as Threatened.

Etymology. The epithet is Latin for elegant, and refers to the attractive habit and flowers.

Notes. *Calectasia elegans* is similar in appearance to *C. gracilis* Keighery, differing in its many-branched habit (*vs* usually few-branched), very slender leaves 0.38–0.53 mm wide (*vs* 0.5–0.6 mm wide), always pungent leaf apices (*vs* obtuse to pungent), prominently ribbed perianth tube 6.5–7.3 mm long (*vs* not or weakly ribbed, 5.7–6.9 mm long) that is pilose in the lower half and with four lines of hairs continuing for the entire length (*vs* lacking four lines of hairs) and smaller anthers, 4.2–4.4 mm long (*vs* 5.0–5.4 mm long).

The vernacular name Elegant Tinsel Lily is suggested.

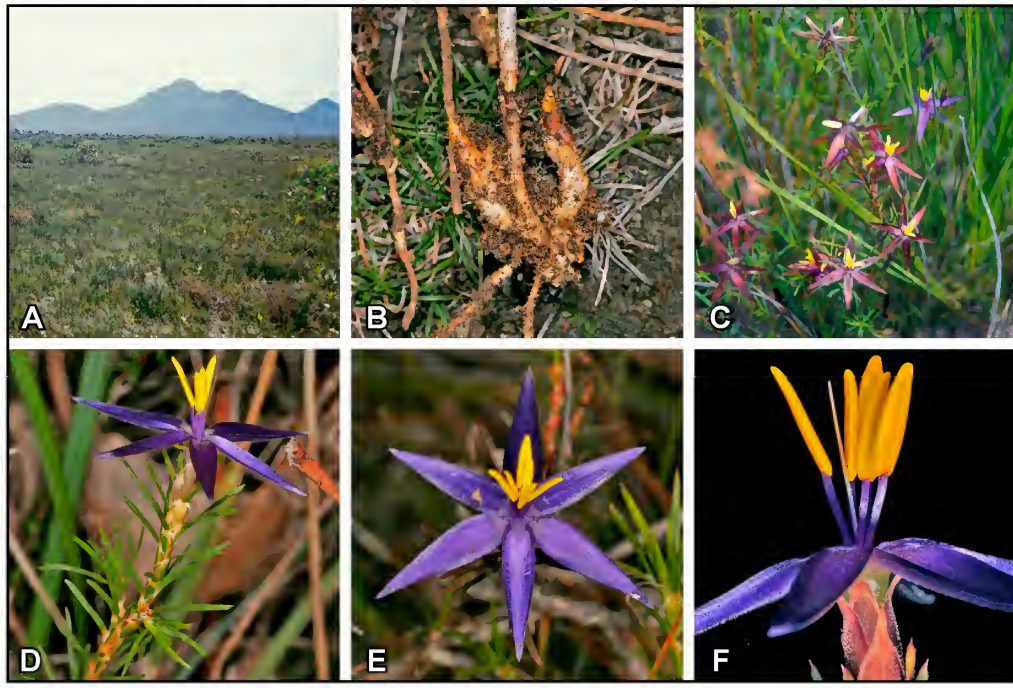

Figure 11. *Calectasia demarzii*. A – habitat of low kwongan heath on sandy plain south of the Stirling Range; B – excavated rhizome; C – flowering branchlets; D – leaves and flower; E – flower; F – anthers and style. Images from *R.L. Barrett & B.R. Gaskell* RLB 3426 (B, D–F) and *R.L. Barrett, K.W. Dixon & M.D. Barrett* RLB 1348 (C). Photographs by R.L. Barrett.

Figure 12. *Calectasia elegans*. A – flowering plant; B – stilt roots; C – flowering branchlets with fresh (yellow) and old (red) anthers; D – lateral view of flower showing hairs on tepals; E – flower showing style; F – prominently ribbed perianth tube. Images from type location, not vouchered. Photographs by R.L. Barrett.

Calectasia jubilaea R.L.Barrett, *sp. nov.*

Type: Cape Le Grand National Park, Western Australia [precise locality withheld for conservation reasons], 14 July 2005, *R.L. Barrett* RLB 2748 (*holo*: PERTH 08617384; *iso*: BM, CANB, K, MEL, NSW).

Clonal perennial; *rhizome* short but spreading, with sand-binding roots. *Stems* to 45 cm high, with many short lateral branches. *Leaves*: *sheath* surface and margins covered with branched trichomes; *lamina* 8–18 mm long, 1.0–1.2 mm wide, shortly hairy below; margins scabrous; apex acute with a pungent mucro 0.3–0.6 mm long. *Bracts* 14–15 mm long, 2.4–2.7 mm wide, papery, white with purple apex, hairy with short, unbranched hairs; outer bracts reddish brown; margins with branched trichomes; apex with vestigial leaf lamina 1.0–3.5 mm long, 1.0–1.2 mm wide. *Perianth* tube 11.5–13.5 mm long, pilose in lower 1/4 with golden to silvery hairs, not prominently costate when dry; lobes 12–14 mm long, 2.6–3.0 mm wide, acute, blue becoming red with age, pilose on abaxial side; margins opaque; throat glabrous above sinus with short hairs inside. *Staminal filaments* 4.6–5.2 mm long. *Anthers* 6.2–6.6 mm long, 0.9–1.2 mm diam., yellow, not turning orange-red with age; pores terminal. *Style* 10.5–11.3 mm long, exceeding anthers. *Seeds* not seen. (Figure 13)

Diagnostic characters. Distinguished from *C. valida* R.L.Barrett by the following combination of characters: *plant* clonal; *rhizome* short but spreading; *perianth* tube 11.5–13.5 mm long, pilose in lower 1/4 with golden to silvery hairs; *perianth* lobes 12–14 mm long, 2.6–3.0 mm wide, becoming red with age; *anthers* 6.2–6.6 mm long, yellow.

Other specimen examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 29 Oct. 2005, *R.L. Barrett & M.D. Barrett* RLB 2927 (PERTH).

Phenology. Flowering and fruiting from July to November.

Distribution and habitat. Known from near Lucky Bay and Mt Ragged east of Esperance in south-western Australia. Occurs in low kwongan dominated by Myrtaceae and Proteaceae.

Conservation status. *Calectasia jubilaea* is to be listed as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). It occurs in Cape Le Grand National Park and Cape Arid National Park and is not under immediate threat.

Etymology. The epithet is from the Latin *jubilaeus*, a celebration, particularly every 50 years, in reference to the 50-year anniversary of the Western Australian Botanic Garden at Kings Park.

Notes. This species is closest to *C. valida*, differing in having a more slender habit, finer leaves and narrower tepals, and in the distribution of the hairs on the perianth tube. It is possibly also related to *C. intermedia* Sond. which has golden hairs on the perianth tube. *Calectasia jubilaea* and *C. valida* co-occur in Cape Arid National Park, growing intermixed.

The vernacular name Jubilee Tinsel Lily is suggested.

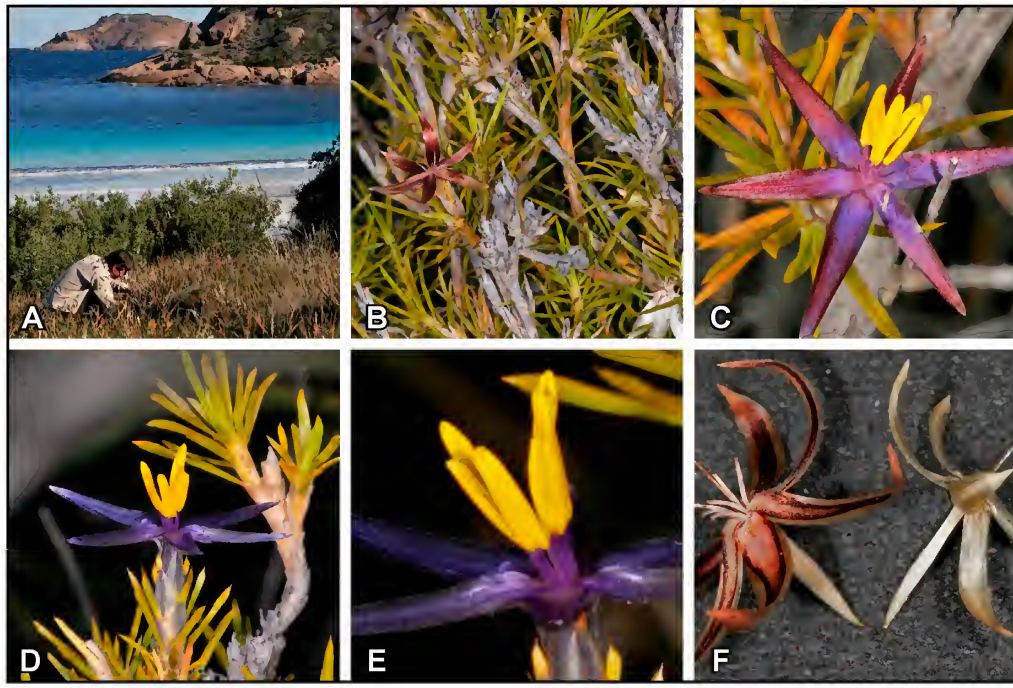

Figure 13. *Calectasia jubilaea*. A – habitat of low kwongan heath on sand over laterite at type location; B – branchlets with old flower; C – flower aging red (note anthers remaining yellow); D – flower; E – anthers; F – old perianth (right) which is pilose in lower quarter of tube and glabrous above (flower on left is *C. valida*). Images from *R.L. Barrett* RLB 2748 (B–E), *R.L. Barrett & M.D. Barrett* RLB 2932 (F, left) and *R.L. Barrett & M.D. Barrett* RLB 2927 (F, right). Photographs by R.L. Barrett.

Calectasia valida R.L.Barrett, *sp. nov.*

Type: Quairading Town Reserve, in north-east section at the junction of the Highway and cemetery entrance road, Western Australia, 20 September 2005, *R.L.Barrett & G. Messina* RLB 2851 (*holo*: PERTH 08614156; *iso*: AD, BM, CANB, K, MEL, NSW).

Calectasia grandiflora (Wheatbelt variant), R.L. Barrett & K.W. Dixon, *Nuytsia* 13: 427, Figure 7A–C (2001).

Calectasia grandiflora subsp. Wheatbelt (A.M. Coates 4315), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Clonal perennial; *rhizome* short, compact, with sand-binding roots. *Stems* to 65 cm high, robust, with many long lateral branches. *Leaves*: sheath with branched trichomes on margin, otherwise glabrous; *lamina* 8.8–12.9 mm long, 0.6–1.3 mm wide, with branched trichomes on abaxial side, becoming glabrous; margins finely scabrous; apex acute with a pungent mucro 0.6 mm long. *Bracts* 11.9–14.9 mm long, 2.7–3.2 mm wide, brown; margins with long branched trichomes; apex with brown vestigial leaf lamina 3.8–4.2 mm long, 0.9–1.3 mm wide. *Perianth* tube (8–)9.2–12.7 mm long, pilose in lower 1/2 to full length, not prominently costate when dry; lobes 8.2–16.2 mm long, 2.0–4.1 mm wide, acuminate, blue-red, fading to pale blue-red, pilose on abaxial side; margins opaque; throat with tangle of short, barbed hairs. *Staminal filaments* 2.7–4.2 mm long, purple. *Anthers* 3.5–6.7 mm long, 0.8–1.5 mm diam., yellow, not turning orange-red with age; pores terminal. *Style* 14.3–17.9 mm long, exceeding anthers. *Seeds* not seen. (Figure 14)

Diagnostic characters. Distinguished from *C. grandiflora* by the following combination of characters: *rhizome* short, compact; *stems* to 65 cm high, robust; *leaf blades* 8.8–12.9 mm long, 0.6–1.1 mm wide; *perianth* tube (8–)9.2–12.7 mm long, pilose in lower 1/2 to full length; *perianth* lobes 8.2–16.2 mm long, 2.0–4.1 mm wide, fading to pale blue-red; *staminal filaments*, 2.7–4.2 mm long; *anthers* 3.5–6.7 mm long, yellow.

Selected specimens examined (*c.* 100 seen). WESTERN AUSTRALIA: slope of hill (N facing) on W side of Bremer Bay, 25 Aug. 1965, *J.C. Anway* 280 (PERTH); 9.1 km E on Norseman Rd from Lake King, N side of road, 26 Oct. 2005, *R.L. Barrett & M.D. Barrett* RLB 2855 (PERTH); along Ravensthorpe–Hopetoun Road, 31.6 km from Ravensthorpe on W side of road, 24 Aug. 1999, *M. Bennett* 504 (PERTH); 0.4 km NW of the 90 mile tank on the Lake King–Norseman Rd, 18 June 2006, *G. Byrne* 2107 (PERTH); Salt River Rd, Cranbrook, 10 Oct. 1982, *E.J. Croxford* 2206 (PERTH); Jingaring Nature Reserve, 8 June 1998, *R. Davis* 6334 (PERTH); Thumb Peak range, 31 Oct. 1965, *A.S. George* 7128 (PERTH); 9 km E of Lake King along road to Kumarl, 13 Oct. 1991, *W. Greuter* 22786 (PERTH); S of Koorarawalyee, 4 Sep. 2009, *J. Jackson* 72 (PERTH); 'Holland's Track' [Holland Track], 7.17 km NW of the Hyden–Norseman Track and 15.7 km from North Ironcap, 18 June 1990, *F.H. & M.P. Mollemans* 2836 (CBG, K, PERTH); E from Solomons Well, 28 Sep. 1902, *A. Morrison s.n.* (PERTH); Esperance Bay district. Neridup, *c.* 3 km NE of Howick Hill, 21 Sep. 1968, *A.E. Orchard* 1110 (AD, PERTH); gate in Rabbit Proof Fence, E of Jerramungup, 13 Aug. 1951, *R.D. Royce* 3691 (PERTH); Lake King–Newdegate Rd, 9 Oct. 2011, *K.R. Thiele* 4352 (PERTH); S side of Kulin–Holt Rock Rd at the W boundary of Dragon Rocks Nature Reserve, 15 Oct. 2003, *J.A. Wege & C. Wilkins s.n.* (PERTH).

Phenology. Flowering from July to October.

Distribution and habitat. Widespread in south-western Australia, and particularly common in the Avon Wheatbelt, occurring from Esperance to north of the Stirling Range, north to Tammin and towards Southern Cross, with a disjunct occurrence near Kalbarri. Commonly found in shrub mallee-heath on white sand or in eucalypt woodland on loam. Recorded in association with *Allocasuarina pinaster*, *Banksia erythrocephala*, *B. sphaerocarpa*, *Beaufortia bracteosa*, *B. micrantha*, *Callitris roei*, *Calytrix leschenaultii*, *Eremaea pauciflora*, *Eucalyptus albida*, *E. pleurocarpa*, *Grevillea cagiana*, *Melaleuca pungens* and *Petrophile ericifolia*.

Conservation status. This species is not under threat, but little of its original habitat remains due to extensive clearing for agriculture.

Etymology. The epithet is from the Latin *validus* (robust) and refers to the robust nature of the species relative to *C. grandiflora*.

Notes. This is a stabilised tetraploid taxon (Barrett & Dixon 2001). It is morphologically closest to the diploid species *C. grandiflora*, differing in its generally shorter staminal filaments (2.7–4.2 mm long *vs* 3.5–4.1 mm), robust habit (*vs* somewhat lax, slender stems), compact rhizome (*vs* somewhat spreading) and thick, broad leaves 0.6–1.3 mm wide (*vs* thin, angular leaves, 0.8–1.2 mm wide).

The vernacular name Robust Tinsel Lily is suggested.

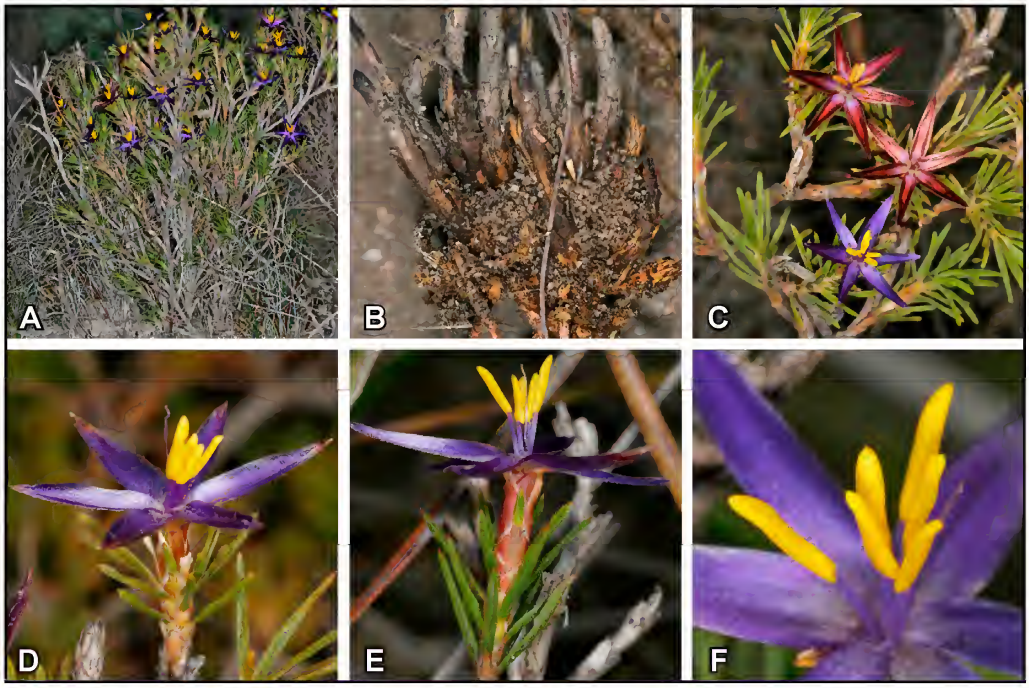

Figure 14. *Calectasia valida*. A – habit; B – compact, robust rhizome; C – flowering branchlets with old and fresh flowers (note anthers remaining yellow); D – flower; E – flower showing reddish floral bracts; F – anthers. Images from *R.L. Barrett & G. Messina* RLB 2851 (A, B); *R.L. Barrett & M.D. Barrett* RLB 2855 (C–F). Photographs by R.L. Barrett.

Eriocaulaceae

Eriocaulon rivicola G.J.Leach, M.D.Barrett & R.L.Barrett, *sp. nov*.

Type: east of the Prince Regent Nature Reserve [National Park], Western Australia [precise locality withheld for conservation reasons], 27 March 2010, *R.L. Barrett & M.D. Barrett* RLB 6730 (*holo*: PERTH 08614172; *iso*: BRI, CANB, DNA, K, MEL, NSW).

Eriocaulon sp. E, G.J. Leach in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1034, Figure 309C (1992).

Eriocaulon sp. E Kimberley Flora (A.S. George 12635), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Submerged, aquatic, usually annual *herb* to 440 mm high. *Leaves* basal, linear, 115–300 mm long, 1.0–2.5 mm wide, 4–12-veined, glabrous or with tangled hairs at base. *Peduncle* 110–440 mm long; sheath 40–65 mm long. *Flower heads* emergent, globular to depressed-globular, 3.0–6.5 mm long, 4.0–7.5 mm diam. *Involucral bracts* translucent, broadly obovate to ovate, 1.5–2.5 mm long, 0.7–1.9 mm wide, glabrous, obtuse, moderately to strongly reflexed at maturity. *Floral bracts* translucent, obovate to lanceolate, 2.0–2.5 mm long, 0.8–1.0 mm wide, glabrous or with sparse to dense white hairs in apical 1/3, acute. *Receptacle* glabrous. *Male flowers*: outer perianth segments 3, black, connate but split on one side, spathe-like, 1.4–1.8 mm long, 0.5–0.8 mm wide, with a dense apical fringe of white hairs, truncate; inner perianth segments 3, translucent, with a dense apical fringe of white hairs, acute, with conspicuous or obscure dark apical gland; *anthers* yellow. *Female flowers*: outer perianth segments

3, equal, translucent, free, linear, acute, 1.0–1.6 mm long, with a few white hairs at apex and sparse, hyaline hairs on margin; inner perianth segments 3, equal, translucent, not thickened, narrowly elliptic to narrowly obovate, 0.8–1.3 mm long, glabrous outside, hairy inside with dense white hairs in upper 1/5–1/2 and sometimes with translucent hairs basally, obtuse, with conspicuous brown to black apical gland or gland obscure; *ovary* 3-locular, sessile; *style branches* 3. *Seeds c.* 0.5 mm long, almost smooth with obscure epidermal cells. (Figure 15)

Diagnostic characters. Distinguished from other *Eriocaulon* L. species by the following combination of characters: plants fully *aquatic* (except emergent inflorescence); *leaves* flattened, in a basal rosette, 115–300 mm long, 1.0–2.5 mm wide; *floral bracts* acute, pale to translucent, typically hairy; *male sepals* connate into a spathe; *anthers* yellow; *female flowers* with outer perianth segments linear, inner perianth segments thin, hairy internally, glabrous outside; *ovary* 3-locular; *style branches* 3; *seeds* with obscure epidermal cells due to persistent outer integument.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 6 July 1993, *M.D. Barrett & R.L. Barrett* MDB 237 (CANB, PERTH); 30 Mar. 2010, *R.L. Barrett & M.D. Barrett* RLB 6879 (CANB, DNA, PERTH); 25 Aug. 1974, *A.S. George* 12635 (PERTH); 31 May 2003, *T. Handasyde* TH 1989 (DNA, PERTH); 22 July 2015, *G.J. Leach* 4733 (BRI, CANB, DNA, PERTH).

Phenology. Flowering and fruiting recorded between March and August.

Distribution and habitat. Known from six locations over a range of about 75 km in the vicinity of the Prince Regent River and York Sound, all on broken sandstone in small, ephemeral or permanent creeks.

Conservation status. *Eriocaulon rivicola* is listed by Jones (2014) as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *E.* sp. E Kimberley Flora (A.S. George 12635).

Etymology. The epithet is from the Latin *rivus* (brook, small stream) and *-cola* (dweller), in reference to the occurrence of this species in small, highly ephemeral or permanent streams on broken sandstone.

Notes. This species was first recognised by Leach (1992) based on a single collection. The combination of a glabrous receptacle, yellow anthers, 3-merous flowers, female sepals lacking a dorsal wing, and male sepals connate into a spathe-like structure place it in a group which includes several other species endemic in the north-west of Australia including *E. patericola* G.J.Leach, *E. scullionii* G.J.Leach, *E.* sp. Morgan River (A.T. Cross ATC 62) and *E.* sp. Harding Range (M.D. Barrett & R.L. Barrett MDB 1826). *Eriocaulon rivicola* differs from all these, and the related *E. cinereum* R.Br., in being much more robust in all parts, most notably the leaves which are 115–300 mm long (usually less than 50 mm long in the other species; up to 90 mm in *E. cinereum*). *Eriocaulon rivicola* differs in ecology from the other species listed, being restricted to fast flowing sandstone rivulets, while the other species are restricted to rockpools (*E. patericola*, *E.* sp. Morgan River, *E.* sp. Harding Range, some populations of *E. cinereum*), sandstone pavements (*E. scullionii*), or seepage and swampy areas, and stream margins (*E. cinereum*).

The species is usually annual, but sometimes occurs in permanent spring-fed creeks and possibly then persists for more than one season.

The vernacular name Sandstone Creek Eriocaulon is suggested.

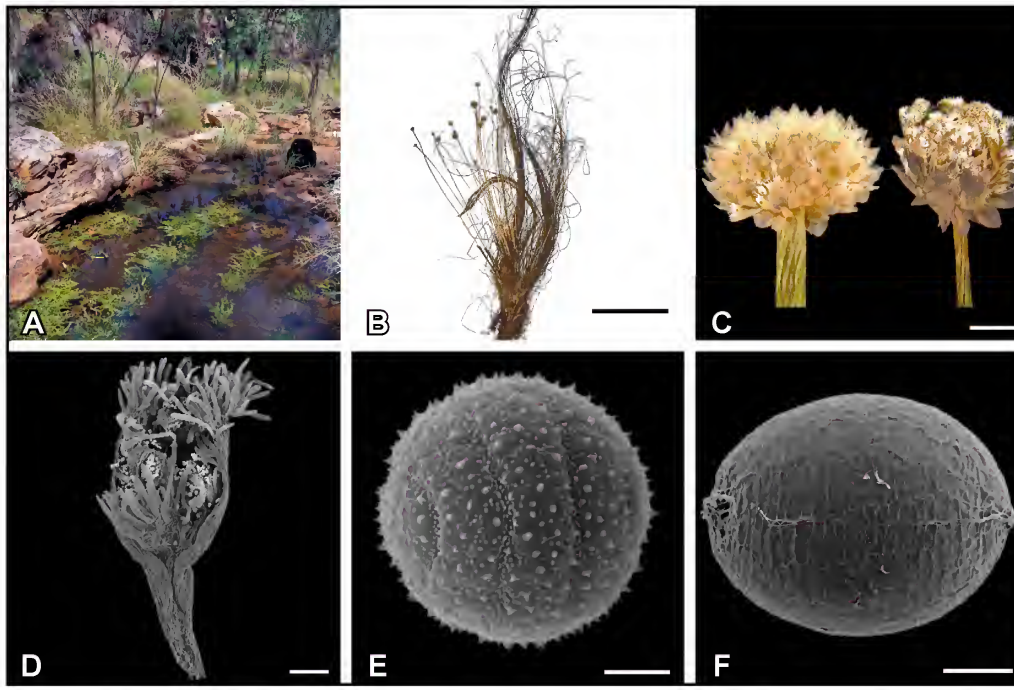

Figure 15. *Eriocaulon rivicola*. A – habitat in ephemeral stream at type location; B – habit; C – inflorescence; D – SEM of a male flower; E – SEM of pollen; F – SEM of seed. Scale bars = 5 cm (B); 2 mm (C); 200 µm (D); 5 µm (E); 100 µm (F). Images from *R.L. Barrett & M.D. Barrett* RLB 6730. Photographs by R.L. Barrett (A); M.D. Barrett (B–F).

Fabaceae

Aphyllodium beardii R.L.Barrett, *sp. nov.*

Type: [Great Sandy Desert,] Western Australia [precise locality withheld for conservation reasons], 4 July 1968, *J.S. Beard* 5685 (*holo*: PERTH 02627329).

Aphyllodium sp. Great Sandy Desert (C.P. Campbell 3689), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Erect to spreading *subshrub* to 0.7 m tall, to 0.8 m diam.; branchlets pilose with hairs 0.5–1.0 mm long; stipules 1.8–5.5 mm long with long marginal hairs. *Leaves* 3-foliolate. *Leaflets* oblong or orbicular, obtuse at base and apex, moderately pilose on both surfaces; terminal and lateral leaflets about equal in size, 2.8–5.6 mm long, 2.6–4.5 mm wide, 1.0–1.2× longer than wide; stipels minute; petiole 2.5–3.8 mm long. *Inflorescence* 13–49 mm long; primary and secondary bracts 2.8–4.0 mm long; *pedicels* 1.1–2.0 mm long. *Calyx* with sparse indumentum of short, uncinate hairs and longer, straight marginal ones, 3.9–4.4 mm long; tube 2.6–3.1 mm long; lobes 0.8–1.7 mm long, subequal, the upper pair slightly longer than the lower 3, broadly triangular. *Corolla* pink, glabrous; *standard* obovate with short claw, 7.1–7.9 mm long, 4.0–4.2 mm wide; *wings* rectangular, auriculate, 5.0–5.5 mm long, 1.1–1.2 mm wide on claw 2.1–3.4 mm long; *keel* slightly longer than wings, narrowly ovate. *Ovary* pubescent. *Style* flattened towards the tip, 7.0–7.5 mm long; *stigma* minute, fringed with hairs. *Pod* a loment of 1 or 2 articles with distinctly raised veins, densely appressed-hairy, greatly constricted on

both sides; articles 5.7–8.2 mm long, 4.2–5.8 mm wide; mature *seeds* not seen (immature seed olive green, 2.6 mm long, 2.0 mm diam.). (Figure 16)

Diagnostic characters. Distinguished from other *Aphyllodium* (DC.) Gagnep. species by the following combination of characters: erect *subshrub* to 70 cm; *leaflets* oblong or orbicular, obtuse at base and apex, moderately pilose on both surfaces, 2.8–5.6 mm long, 2.6–4.5 mm wide, 1.0–1.2× longer than wide; *pods* of 1 or 2 densely appressed-hairy articles, each 5.7–8.2 mm long and 4.2–5.8 mm wide.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 11 June 1996, *B. Allwright s.n.* (PERTH 05585090); 30 Aug. 2001, *C.P. Campbell* 3689 (PERTH); 27 June 2009, *G.F. Griffin & S.R. Dunlop* GSD 09-68 (PERTH).

Phenology. Flowering and fruiting from June to August.

Distribution and habitat. Known only from the north-west of the Great Sandy Desert where it grows on the crests of red sand dunes with *Dampiera cinerea*, *Dicrastylis cordifolia*, *Gompholobium simplicifolium*, *Newcastelia cladotricha* and *Triodia epactia*.

Conservation status. *Aphyllodium beardii* is listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *A.* sp. Great Sandy Desert (C.P. Campbell 3689).

Etymology. The epithet recognises the work of the late John Beard (1916–2011), former director of Kings Park and Botanic Garden, who first collected this species while mapping the vegetation of Western Australia (Beard & Webb 1974; Beard 1980, 1990).

Notes. Pedley (1999) included material of *A. beardii* when preparing his description of *A. parvifolium* Pedley, and even intended to base that name on the specimen here designated as the holotype of *A. beardii* (see annotations on PERTH 02627329). Instead, Pedley designated a collection from north of Broome as the type of *A. parvifolium* (PERTH 01112694) which he considered to be the same taxon. Specimens matching the type of *A. parvifolium* are, however, distinct from *A. beardii*, differing in their decumbent habit, narrowly ovate leaflets with more or less appressed hairs, elongate inflorescence, and pods with two or three articles. The two species are disjunct, with *A. beardii* restricted to red sand dunes in the north-western Great Sandy Desert, and *A. parvifolium* endemic on the Dampier Peninsula between Willie Creek and Taylors Lagoon where it is highly restricted to seasonally wet swamps and creek margins. The type population of *A. parvifolium* cannot be relocated and it has possibly become locally extinct due to a combination of fire and grazing by cattle. *Aphyllodium parvifolium* is actually more closely related to *A. biarticulatum* (L.) Gagnep. and its relationship with that taxon requires further examination. The inflorescence is contracted relative to *A. biarticulatum*, but the two taxa are otherwise very similar. As part of a review of *A. biarticulatum*, a new description of *A. parvifolium* should also be prepared since Pedley's (1999) description relates best to the specimens here referred to *A. beardii*.

The vernacular name Beard's Sand Dune Pea is suggested.

Figure 16. *Aphyllodium beardii*. A – habit and habitat on sand dune crest; B – inflorescence; C – leaves and fruit. *Aphyllodium parvifolium*. D – decumbent habit; E – leaves and inflorescence; F – infructescence. Images from *C.P. Campbell* 3689 (A–C) and *R.L. Barrett, K.F. Kenneally & T. Willing* RLB 5580 (D–F). Photographs by C.P. Campbell (A–C); R.L. Barrett (D–F).

Bossiaea Vent.

The four *Bossiaea* species recognised here are clearly most closely related to each other based on their morphological characteristics. The closest relative of this group is presumed to be *B. armitii* F.Muell. from northern Queensland and the adjacent Northern Territory, the only other leafless *Bossiaea* species with an entirely tropical distribution (see Thompson 2012). Ross (2006) noted that the hairs in the sinus of the keel of *B. bossiaeoides* (A.Cunn. ex Benth.) Court are unusual in the genus. The two new species described here both share that feature, confirming their relationship with *B. bossiaeoides*. The shape of the calyx lobes and inflorescence type is also similar, though *B. bossiaeoides* often has more than two flowers per axil, while the other species usually only have one or two.

Key to *Bossiaea* species in the Kimberley region of Western Australia

1. Stems scarcely winged; decumbent subshrub; standard and keel petals glabrous ..... **B. barrettiorum**

1: Stems distinctly winged; erect subshrub; standard and keel petals sparingly to densely pubescent in the sinus **2**

2. Stem wings serrated in outline, at their widest prominently exceeding nodes; standard 15–19 mm long; keel <twice as long as wings ..... **B. bossiaeoides**

2: Stem wings ±even in width, not or scarcely exceeding nodes; standard 8.5–14 mm long; keel ≥twice as long as wings **3**

3. Lower stems to 11 mm wide; upper stems usually <4 mm wide, dark green to sub-pruinose; ultimate branches of cladodes 1.9–3.4(–6.3 when young) mm wide; pedicels 1.5–5.8 mm long in flower, to 7 mm long in fruit; standard 8.5–12.6 mm long, 7.0–9.1 mm wide; keel 12.1–15.4 mm long, >twice as long as wings; seedling leaves narrowly ovate, 28–34 mm long, 6.5–9 mm wide, the petiole *c.* 3.2 mm long ..... **B. zarae**

3: Lower stems to 17 mm wide; upper stems usually 6–9(–15) mm wide, usually pruinose; ultimate branches of cladodes 6–18(–31) mm wide; pedicels 3.4–8.9 mm long in flower, 7–14 mm long in fruit; standard 10.3–13.7 mm long, 10.2–13 mm wide; keel 13.2–17.9 mm long, ±twice as long as wings; seedling leaves orbicular to obovate, 14–22 mm long, 7–13 mm wide, the petiole 2.7–7 mm long ..... **B. arenitensis**

Bossiaea arenitensis R.L.Barrett, *sp. nov.*

Type: Crinia Flat (informal name), 9.8 km east-north-east of Mount Jameson; 6.6 km south-east of Mount Agnes, Mount Elizabeth Station, north of Munja track, Western Australia, 28 January 2007, *R.L. Barrett & M.D. Barrett* RLB 4045 (*holo*: PERTH 08103925; *iso*: CANB, CNS, DNA, K, MEL, NSW).

Bossiaea sp. West Kimberley (R.L.Barrett & M.D.Barrett RLB 4045), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 17 April 2014].

Erect *shrub* to 2.5(–5) m high and 1–2(–4) m diam., many-branched. *Seedlings* with orbicular to obovate leaves, 14–22 mm long, 7–13 mm wide, the petiole 2.7–7 mm long. *Stems* oval, elliptic or flattened in TS, winged, up to 17 mm wide, pruinose, almost glabrous apart from hairs in axils of scale leaves; ultimate branches of cladodes 6–18(–31) mm wide, winged; wings not broader than, and incised at, nodes. *Leaves* reduced to dark brown, scarious, narrowly ovate scales 2.2–2.7 mm long, glabrous apart from marginal cilia. *Flowers* solitary or paired at nodes; *pedicels* 3.4–8.9 mm long in flower, 7–14 mm long in fruit, glabrous; *bracts* imbricate, narrowly ovate, increasing in size from the outer to the inner, the inner to 2.8 mm long and similar to the bracteoles, inconspicuously longitudinally striate, glabrous apart from marginal hairs especially towards apex and sometimes along midline apically, chestnut brown, persistent; *bracteoles* narrowly ovate, 1.3–1.8 mm long, inserted at about middle of pedicel, glabrous, inconspicuously longitudinally striate, persistent. *Calyx* glabrous outside apart from hairs on margins of lobes, 6.3–9.5 mm long, suffused with red; 3 lower lobes 1.7–1.9 mm long, acute, shorter than tube; 2 upper lobes rounded-truncate, diverging at apex, obtuse, free, 2.9–4.3 mm long. *Corolla*: *standard* 10.3–13.7 mm long including a claw 3.3–4.0 mm long, 10.2–13 mm wide, shorter than keel, golden yellow internally with a continuous, red, horseshoe-shaped basal flare around a paler yellow throat, externally yellow-orange with faint, red, longitudinal striations radiating from base into lamina; *wings* 7.0–8.9 mm long including a claw 3.2–3.6 mm long, 2.5–3.1 mm wide, distinctly auriculate basally, uniformly yellow or flushed with orange, glabrous; *keel* 13.2–17.9 mm long including a claw 4.8–5.8 mm long, 3.6–6.5 mm wide, externally yellow to burgundy, hairy apically in the sinus. *Staminal filaments* 6.7–16.0 mm long. *Ovary* 6.8–13.1 mm long, on a stipe to 2.4 mm long, 8–11-ovulate, glabrous. *Style* 1.1–5.5 mm long. *Pods* oblong, 36–49 mm long, 6.8–10.8 mm wide; stipe exceeding calyx, 6.5–9.5 mm long; valves inconspicuously transversely veined, glabrous, dark reddish brown when mature. *Seeds* ellipsoid, 3.6–3.8 mm long, 1.9–2.2 mm diam., chestnut brown with subtle, darker mottles; *aril* white, comma-shaped, 1.5 mm long. (Figure 17)

Diagnostic characters. Distinguished from *B. bossiaeoides* by the following combination of characters: erect *shrub* to 2.5(–5) m high, conspicuously pruinose; *stems* winged, the wings not broader than the

nodes; ultimate branches of cladodes 6–18(–31) mm wide; *pedicels* 3.4–8.9 mm long; *standard* golden yellow, 10.3–13.7 mm long; *keel* 13.2–17.9 mm long.

Other specimens examined. WESTERN AUSTRALIA: 20 km E of Tableland Station Homestead, 1 July 1972, *T.E.H. Aplin* 5102 (PERTH); sandstone ridges around summit of Mt Bomford, 5 Jan. 2001, *R.L. Barrett & M.D. Barrett* RLB 1539 (PERTH); on W side of gorge on S Bachsten Creek, level with falls, 23 Jan. 2007, *R.L. Barrett & M.D. Barrett* RLB 3790 B (PERTH); Roe River pavement 1, on mainland, 3 km ESE of Gertrude Cove on Kiska Island, 23 Apr. 2008, *R.L. Barrett & M.D. Barrett* RLB 4567 (PERTH); Roe Sinkhole, Prince Regent Nature Reserve, 19 Jan. 2010, *R.L. Barrett, M. Maier & P. Kendrick* RLB 6299 (MEL, PERTH); Little Mertens Falls, Mitchell Plateau, 24 Jan. 2010, *R.L. Barrett & M.D. Barrett* RLB 6474 (CANB, PERTH); *c.* 1.5 km E of Mount Russ, 28 Mar. 2010, *R.L. Barrett & M.D. Barrett* RLB 6765 (NSW, PERTH); gutter swamp site, N of Bachsten Gorge, Prince Regent Nature Reserve, 13 Mar. 2014, *R.L. Barrett* RLB 9018 (CANB, DNA, PERTH); Naturalist Island in Prince Frederick Harbour at mouth of Hunter River, 21 June 1984, *M. Evans* 11 (CANB, PERTH); at the beginning of the trail to Mitchell Falls, near the helicopter pad in the camping area, Kimberley, 26 Apr. 1996, *G. Graham* 4 (PERTH); *c.* 7 km WSW of the beginning of the trail to Mitchell Falls near the helicopter pad in the camping area, 25 Apr. 1996, *G. Graham* 35 (PERTH); N side of Boomerang Bay, Bigge Island, 2 June 1972, *N.G. Marchant* 72/89 (MEL, PERTH); loc. 2, Katers Island, 10 June 1972, *N.G. Marchant* 72/299 (PERTH).

Phenology. Flowering from January to April. Fruiting from February to July.

Distribution and habitat. Reasonably widespread in the west Kimberley, from Bachsten Creek and the Prince Regent River north to the Mitchell Plateau and Bigge Island, with a disjunct record from Tableland Station. Grows on broken sandstone ridges, outcrops, creek beds, or below cliffs, in grey sand in low, open woodland of *Corymbia* and *Eucalyptus* over low shrubs and grasses including *Triodia*. There is a single record from dolerite, but this was probably an instance of sandstone-derived soils overlying dolerite.

Conservation status. Reasonably widespread in the west Kimberley and not considered threatened. It is conserved within Prince Regent National Park.

Etymology. The epithet is derived from arenite (sandstone) and refers to the substrate this species grows on.

Notes. *Bossiaea arenitensis* is closely related to *B. bossiaeoides*, sharing broad stem-wings and large flowers, but is distinguished by its stem-wing segments, which do not or scarcely exceed the node width and are conspicuously pruinose. It is also distinguished by its shorter standard (10.3–13.7 mm long *vs* 15–19 mm in *B. bossiaeoides*). Unlike *B. bossiaeoides*, *B. arenitensis* grows on sandstone ridges (*vs* sand flats in woodland); both species can be found growing in close proximity, or rarely with a very narrow zone of overlap, at the base of sandstone scree. Ross (2006) notes that *B. bossiaeoides* is variable with respect to flower size and stem-wing width, but no specimens of *B. arenitense* were seen by him. *Bossiaea arenitensis* is also similar to *B. zarae*, a species with narrower stem-wings, smaller flowers and shorter pedicels, and which grows on sandstone pavements.

Plants of *B. arenitensis* are generally killed by fire, in contrast to *B. bossiaeoides* which can usually resprout.

The vernacular name Sandstone Winged Pea is suggested.

Figure 17. *Bossiaea arenitensis*. A – habitat on broken sandstone ridges; B – habit; C – seedling; D – flower showing pale keel with pink flecks; E – flowering branchlets showing red-backed standard in unopened flowers; F – fruit; G, H – partially dissected flower; I – flower with keel and wings removed to show auricles at base of standard. Images from *R.L. Barrett & M.D. Barrett* RLB 4045. Photographs by R.L. Barrett.

Bossiaea zarae R.L.Barrett, *sp. nov.*

Type: Bigge Island, Kimberley, Western Australia [precise locality withheld for conservation reasons], 17 February 2008, *M.N. Lyons & G.J. Keighery s.n.* (*holo*: PERTH 08635056 [sheet 1 of 2], PERTH 08635137 [sheet 2 of 2]); *iso*: CANB, DNA).

Bossiaea sp. Princess May Range (M.D. Barrett & R.L. Barrett MDB 1326), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 17 April 2014].

Erect *shrub* to 2.2 m high and 1.2 m diam., many-branched. *Seedlings* with narrowly ovate leaves, 28–34 mm long, 6.5–9 mm wide, the petiole *c*. 3.2 mm long. *Stems* oval, elliptic or flattened in TS,

winged, up to 11 mm wide, not pruinose, almost glabrous apart from hairs in axils of scale leaves; ultimate branches of cladodes 1.9–3.4(–6.3 when young) mm wide, winged; wings not broader than, and scarcely incised at, nodes. *Leaves* reduced to dark brown, scarious, narrowly ovate scales 1.1–2.0 mm long, glabrous apart from marginal cilia. *Flowers* solitary or paired at nodes; *pedicels* 1.5–5.8 mm long in flower, to 7 mm long in fruit, glabrous; *bracts* imbricate, narrowly ovate, increasing in size from the outer to the inner, the inner to 2.1 mm long and similar to the bracteoles, inconspicuously longitudinally striate, glabrous apart from marginal hairs especially towards the apex and sometimes along the midline apically, chestnut brown, persistent; *bracteoles* narrowly ovate, 0.9–1.1 mm long, inserted at about the middle of the pedicel, glabrous, inconspicuously longitudinally striate, persistent. *Calyx* glabrous outside apart from hairs on the margins of lobes, 5.3–7.0 mm long, suffused with red; 3 lower lobes 1.1–1.4 mm long, acute, shorter than tube; 2 upper lobes rounded-truncate, diverging at apex, obtuse, free, 1.7–2.5 mm long. *Corolla*: *standard* 8.5–12.6 mm long including a claw 2.8–3.2 mm long, 7.0–9.1 mm wide, shorter than keel, golden yellow internally with a faint, discontinuous, red-brown, horseshoe-shaped basal flare around a paler yellow throat, externally yellow with faint, red-brown, longitudinal striations radiating from the base into lamina; *wings* 5.3–6.3 mm long including a claw 1.5–2.0 mm long, 1.8–2.3 mm wide, distinctly auriculate basally, uniformly yellow, glabrous; *keel* 12.1–15.4 mm long including a claw 2.5–3.4 mm long, 4.8–6.0 mm wide, externally pale yellow or greenish yellow, hairy apically in the sinus. *Staminal filaments* 10.0–13.2 mm long. *Ovary* 7.2–9.9 mm long, on a stipe to 1.5 mm long, 13- or 14-ovulate, glabrous. *Style* 4.4–4.8 mm long. *Pods* oblong, (29–)43–47 mm long, (5.5–)6.6–7.1 mm wide; stipe greatly exceeding calyx, 5.0–7.9 mm long; valves inconspicuously transversely veined, glabrous, dark reddish brown when mature. *Seeds* ellipsoid, 3.1–3.7 mm long, 1.8–2.1 mm diam., mostly black with brown mottles; *aril* white, comma-shaped, *c.* 1.1 mm long. (Figure 18)

Diagnostic characters. Distinguished from *B. bossiaeoides* by the following combination of characters: erect *shrub* to 2.2 m high and 1.2 m diam.; *leaves* scale-like; *stems* very narrowly winged, the wings not broader than the nodes; ultimate branches of cladodes 1.9–3.4(–6.3 when young) mm wide; *standard* golden yellow, 8.5–12.6 mm long; *wings* 5.3–6.3 mm long; *keel* 12.1–15.4 mm long.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 19 Jan. 2003, *M.D. Barrett & R.L. Barrett* MDB 1326 (PERTH); 20 Jan. 2003, *M.D. Barrett & R.L. Barrett* MDB 1350 (PERTH); 21 Jan. 2003, *M.D. Barrett & R.L. Barrett* MDB 1362 (PERTH); 25 Jan. 2007, *R.L. Barrett & M.D. Barrett* RLB 3906 (PERTH); 25 Jan. 2007, *R.L. Barrett & M.D. Barrett* RLB 3949 (PERTH); 28 Jan. 2007, *R.L. Barrett & M.D. Barrett* RLB 4060 (PERTH); 19 Jan. 2010, *R.L. Barrett, M. Maier & P. Kendrick* RLB 6292 (PERTH).

Phenology. Flowering and fruiting recorded for January.

Distribution and habitat. Restricted to sandstone pavements or low, fire-protected sandstone ridges in the Kimberley region, occurring between the headwaters of the Prince Regent River and the Princess May Ranges, and further north on Bigge Island. Grows in low shrubland or with scattered trees over *Triodia* spp.

Conservation status. *Bossiaea zarae* is listed by Jones (2014) as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *B.* sp. Princess May Range (M.D. Barrett & R.L. Barrett MDB 1326); however, it has recently been downgraded to Priority Three (Western Australian Herbarium 1998–). Current records suggest *B. zarae* is uncommon. It is known from only six populations, two of which are within Prince Regent National Park. All

known populations are locally restricted by the extent of their habitat, and are potentially threatened by changes in fire regime.

Etymology. From the Arabic and Hebrew name Zara (meaning princess), used here in reference to the Princess May Ranges where this species was first recognised as distinct.

Notes. *Bossiaea zarae* is closely related to *B. barrettiorum* J.H.Ross, sharing very narrow stem-wings, but distinguished by its erect habit, slightly broader stem-wing segments, larger flowers (standard 8.5–12.6 mm long *vs* to 9.2 mm long) and by having scattered hairs in the sinus of the keel (*vs* glabrous). It is also similar to *B. arenitensis*, a species with much broader stem wings, larger flowers, and longer pedicels and peduncles, and which grows on sandstone ridges and scree. *Bossiaea arenitensis* and *B. zarae* have both been found at the same location, growing in adjacent habitats.

The vernacular name Princess May Winged Pea is suggested.

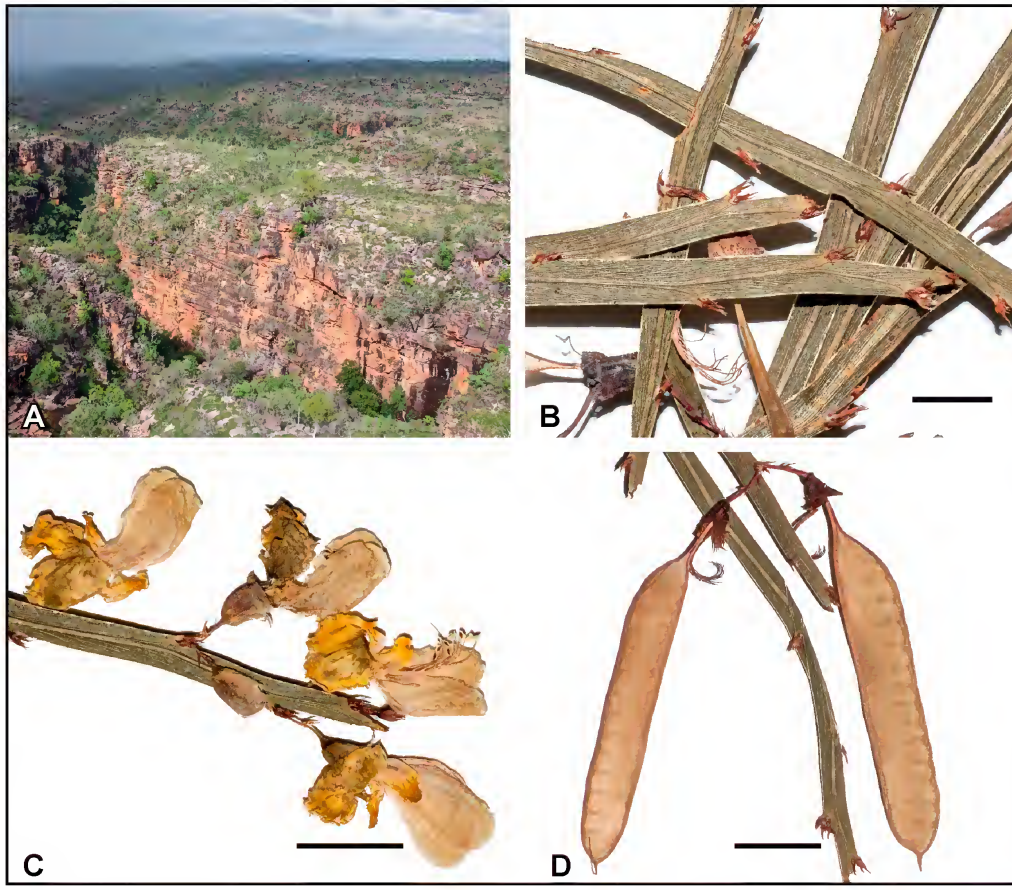

Figure 18. *Bossiaea zarae*. A – sandstone mesa habitat in Prince Regent National Park; B – cladodes showing very narrow stem wings; C – flowering cladode; D – fruit. Scale bars = 5 mm (B), 1 cm (C, D). Images from the holotype *M. Lyons & G.J. Keighery s.n.* (B–D). Photographs by R.L. Barrett.

Glycine remota M.D.Barrett & R.L.Barrett, *sp. nov.*

Type: east-north-east of junction of Pitta Creek and Prince Regent River, Western Australia [precise locality withheld for conservation reasons], 11 January 2001, *M.D. Barrett* 1201 (*holo*: PERTH 06348157).

Glycine sp. Pitta Creek (M.D. Barrett 1201), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 17 April 2014].

Lax, prostrate, perennial *herb*, to 0.15 m high and 2 m diam.; *taproot* distinctly woody, *c.* 190 mm long, *c.* 11 mm diam. at widest point, conical with ±truncate apex. *Stems* not rooting at nodes, 0.5–0.7 mm diam., subterete, elliptic or angular, weakly to moderately ribbed but not winged, tomentose with mostly pale ferruginous (some white) hairs that are mostly erect (some spreading) and very variable in size and thickness, 0.1–1.1 mm long. *Stipules* 2.5–4.3 mm long, 1.1–1.5 mm wide, lanceolate, long-acute, with 5–7 strong veins, weakly ribbed, broadly attached at the obtuse base (i.e. not peltate or cordate). *Leaves* unifoliolate; *petiole* 15–26 mm long, indumentum as for stems; *stipels* 2, linear, acute to narrowly subulate, 1.7–2.0 mm long, 1-veined, the vein strongly produced and moderately tomentose on abaxial surface; *petiolule* 1.3–2.0 mm long; *leaflet* 24–42 mm long, 17–39 mm wide, ovate, obtuse, rounded to very broadly obtuse at base, L:W ratio (1.1–)1.5–2.3:1, ±concolorous, moderately to sparsely hairy above, the hairs densest along veins and mostly white except on margins where mostly pale ferruginous, sparser below; secondary veins 7 or 8 on each side of midrib; tertiary venation reticulate, prominent, slightly raised on adaxial surface, prominently raised on abaxial surface. *Inflorescence* axillary, of (apparently) chasmogamous flowers in terminal condensed-racemose clusters on short shoots; *peduncle* 2–11 mm long, with moderately dense, white, appressed-ascending to ascending hairs; rachis 1.5–4.0 mm long, bearing *c.* 6–9 flowers, indumentum as for peduncle; *pedicels* 0.5–1.0 mm long, glabrous; *bracts* 1.7–2.7 mm long, subulate, prominently 1-veined on adaxial surface, moderately densely hairy, the hairs appressed-ascending; *bracteole* 1 at apex of each pedicel, 2.0–2.2 mm long, subulate, prominently 1-veined on adaxial surface, moderately densely clothed with appressed-ascending hairs. *Calyx c.* 4.6 mm long including tube, moderately densely appressed-hairy with white hairs outside, greenish; tube *c.* 2.1 mm long; 3 lower lobes 2.1–2.4 mm long, slightly longer than tube, acute; 2 upper lobes *c.* 2.4 mm long, joined for most of their length but free for distal 0.4–0.5 mm, the apex erect, acute. *Corolla*: *standard c.* 7.0 mm long including a claw *c.* 1.8 mm long, *c.* 4.0 mm wide, slightly longer than keel, sharply folded along centre line; apex rounded with a slight notch, white to pale cream; *wings c.* 6.1 mm long including a claw *c.* 2.1 mm long, *c.* 1.2 mm wide, equalling keel, distinctly auriculate basally (auricle *c.* 0.8 mm long), shortly fused to keel just above claw, uniformly white to cream, not blackening with age, glabrous; *keel c.* 6.1 mm long including a claw *c.* 2.0 mm long, *c.* 2.5 mm wide when flattened, notched at apex for *c.* 1 mm, pink with a pale midline and claw, glabrous. *Stamens* 10; filaments 5.3–5.9 mm long, connate into a tube for 2/3–3/4 of their length; vexillar stamen freer than others; *anthers c.* 0.45 mm long. *Ovary c.* 2.2 mm long at anthesis, on a stipe *c.* 0.5 mm long, 3-ovulate, glabrous except for a line of moderately dense, colourless, appressed hairs on upper midline. *Style* upcurved, *c.* 4.0 mm long, tapering to the stigma, glabrous except for a line of colourless, appressed hairs on upper side in basal 1/2 and a few sparse hairs on lower midline at the base; stigma capitate, *c.* 0.2 mm diam., surrounded by a ring of erect, colourless hairs *c.* 0.05 mm long. *Legume* oblong, non-moniliform, 11–23 mm long, 4.5–6.0 mm wide; stipe 1–2 mm long; valves not transversely veined, moderately densely white and pale ferruginous-hairy, pale brown when mature, non-striate, containing 1–3 seeds; style persistent, straight or upcurved, *c.* 1 mm long. *Seeds* oblong-subreniform, with ends ±truncate, 3.4–3.5 mm long, 2.3–2.6 mm wide, *c.* 2.0 mm thick, L:W ratio *c.* 7:5, black, not mottled, minutely alveolate

and tuberculate; caruncle small, flap-like, *c.* 0.6–0.7 mm long, cream. *Cleistogamous subterranean flowers* not seen. (Figure 19)

Diagnostic characters. Distinguished from all *Glycine* Willd. species by the following combination of characters: *leaves* unifoliolate, leaflets ovate; *stem indumentum* pale ferruginous; *peduncles* 2–11 mm long; *flowers* in condensed axillary clusters; *corolla* white to pale cream with a pink keel; *seeds* black, alveolate and tuberculate.

Other specimen examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 27 Mar. 2010, *M.D. Barrett & R.L. Barrett* MDB 2845 (CANB, DNA, PERTH).

Phenology. Flowering and fruiting observed in January; fruiting also in March.

Distribution and habitat. Known from a single location in the vicinity of Pitta Creek, growing in *Eucalyptus miniata-E. tetrodonta* woodland in sandy soil on sandstone slopes.

Conservation status. *Glycine remota* is listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *G.* sp. Pitta Creek (M.D. Barrett 1201). Few plants are known at the only known location. The note on *M.D. Barrett* 1201 states that plants are 'relatively common', but this mistakenly refers to a similar looking pea (a *Galactia* sp.) which has the same habit and is abundant at the site, and greatly hinders searches for plants of the much rarer *Glycine*.

Etymology. The epithet is from the Latin *remotus* (remote), in reference to the only known population being distant from population centres and roads.

Notes. Differs from all other Australian *Glycine* species in having unifoliolate leaves (digitately or pinnately trifoliolate in other species). Similar to *G. lactovirens* Tindale & Craven and *G. albicans* Tindale & Craven, sharing white flowers in condensed clusters, more or less ovate leaflets, black, alveolate and tuberculate seeds, and north-west Kimberley distribution. *Glycine lactovirens* and *G. albicans* form a clade and are given a unique *Glycine* genome designation, the 'I Genome' (Brown *et al.* 2002). *Glycine remota* is close to *G. lactovirens* and almost certainly belongs to the same clade; it is most likely (if diploid) to have the same genome group. In addition to being unifoliolate, it differs from *G. lactovirens* and *G. albicans* in having much shorter peduncles (2–11 mm long *vs* 15–90 mm long), smaller, oblong seeds (3.4–3.5 mm long with a L:W ratio of 7:5 in *G. remota vs* 4.0–5.5 mm with a

Figure 19. *Glycine remota*. A – habit; B – tuberous tap root and trailing stem; C – unifoliolate leaf and fruit. Images from *M.D. Barrett & R.L. Barrett* MDB 2845. Photographs by R.L. Barrett.

L:W ratio of 6:5 and more or less rounded). It differs further from *G. albicans* in having a ferruginous stem indumentum (*vs* white). In the key to *Glycine* of north-west Australia (Pfeil & Craven 2002), *G. remota* would key to *G. lactovirens*, differing in the characters mentioned above.

The description above is based on dissection of a single flower, due to the limited available material on the type specimen.

The vernacular name Prince Regent Soybean is suggested.

The key in Pfeil *et al.* (2006) can be modified to include *G. remota* as follows:

3. Plant moderately erect; leaflet abaxial surface hairs dense, abaxial areoli obscured by hairs; rhizome bearing cleistogamous flowers or fruit..... **G. albicans**

3: Plant prostrate; leaflet abaxial surface hairs moderately dense to dense, abaxial areoli not obscured by hairs; usually not rhizomatous (if so, then lacking cleistogamous flowers or fruit)

3A. Leaves unifoliolate; peduncles 2–11 mm long ..... **G. remota**

3A: Leaves digitately or pinnately trifoliolate; peduncles 15–90 mm long

4. Leaves digitately trifoliolate; calyx *c.* 5 mm long; standard petal 7–7.5 mm long; petiole and abaxial leaflet hairs cream or pale ferruginous..... **G. lactovirens**

4: Leaves pinnately trifoliolate; calyx up to 2.5 mm long; standard petal 5 mm long; petiole and abaxial leaflet hairs white..... **G. montis-douglas**

Loganiaceae

Mitrasacme thedae M.D.Barrett & R.L.Barrett, *sp. nov.*

Type: Theda Station, Western Australia [precise locality withheld for conservation reasons], 16 February 2006, *R.L. Barrett & M.D. Barrett* RLB 3121 (*holo*: PERTH 08615241; *iso*: BRI, CANB, DNA, K, MEL, NSW).

Mitrasacme sp. Theda (K. Menkhorst s.n. 18/04/1988), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Annual *herb*, 32–70(–100) cm high, glabrous. *Stem* an erect scape, solitary, terete, 1.0–1.9 mm diam. in mid-section, thinner at base, hollow. *Leaves* 2–4 pairs in a basal rosette, withering before fruiting, sessile, ovate to broadly elliptic, 23–52 mm long, 7.5–25 mm wide, subacute to obtuse, strongly 3-veined, glabrous. *Inflorescence* compound, of 1–3 umbels of 1–7 flowers each. *Pedicels* terete, 7–30 mm long, 0.4–0.9 mm thick, glabrous. *Calyx* strongly ribbed at anthesis, swollen and ±cylindrical in fruit, 4.5–5.5 mm long including lobes; tube 2.5–4.5 mm long, with green to white scale-like projections between the thickened, 3-veined, glabrous ribs; lobes 1–2 mm long, with a dark-coloured, thickened central part extending above the membranous margins, acute. *Corolla* white with a small, round, green spot each side of the base of each lobe (making an interrupted green ring around the throat), with pale apricot flush on abaxial surface and unopened buds, 40–45 mm diam.; tube cylindrical, 12–19 mm long, 1.0–1.2 m diam. in basal 2/3, dilated to 2.0–3.5 mm diam. in upper 1/3 but reducing abruptly to 1.5–1.6 mm diam. at throat, glabrous or with sparse, short, erect hairs in upper 1/4 of tube outside, mostly glabrous at throat with a narrow band of small scale-like hairs around the rim and tangled hairs inside at base; lobes connate in basal 1.2–1.9 mm from throat, 9–18 mm long, 6.2–11.0 mm wide, each

with a blunt, retrorse lobe at the throat opening, obtuse with a short apiculus; throat square. *Stamens* all fertile or rarely some reduced to staminodes, inserted in upper 1/4 of tube, 8–12 mm long; filaments adnate to tube along much of their length forming vertical ribs, free for *c.* 0.2 mm. *Anthers* ±sessile, included, linear to oblong, (1–)1.8–2.3 mm long, latrorse. *Style* included, 12–17 mm long at anthesis, gradually dilating toward tip, with 2 flattened lobes at apex; lobes obovate, obtuse, 0.6–1.3 mm long. *Capsule* globular, 4–6 mm long (including horns), 3.7–4.2 mm diam., glabrous; horn apices connate; style 9.0–14.5 mm long, falling early. *Seeds* not seen. (Figure 20)

Diagnostic characters. Distinguished from *M. elata* R.Br. and *M. nudicaulis* Reinw. ex Blume by the following combination of characters: *leaves* large (23–52 mm long), 3-veined, in a basal rosette; *flowers* large, white with small, green spots at the base of each lobe, with a pale apricot flush on the abaxial surface, and a distinctly square mouth to the corolla tube.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 12 Apr. 2013, *R.L. Barrett, M.D. Barrett & B. Anderson* RLB 8008 (PERTH); 7 Mar. 2014, *R.L. Barrett* RLB 8825 (BM, BRI, CANB, DNA, K, L, MEL, NSW, PERTH); 18 Apr. 1988, *K. Menkhorst s.n.* (DNA, MEL, PERTH 03461629).

Phenology. Flowering and fruiting recorded from January to April.

Distribution and habitat. Locally common in places on Theda Station and south of Kalumburu in the North Kimberley. Occurs on red, basalt-derived soils on rocky slopes and in flat areas, in open woodland. Suitable habitat is more or less continuous over many of the basalt hills on Theda Station, west to the Mitchell Plateau and north towards the Carson River, which coupled with available collections suggests a likely broader distribution for the species.

Conservation status. *Mitrasacme thedae* is listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *M.* sp. Theda (K. Menkhorst s.n. 18/04/1988).

Etymology. The epithet is derived from the name of the station where this species is found. Theda Station was apparently named for Theda, the wife of the founder of the station lease, hence the feminine gender.

Notes. *Mitrasacme thedae* is similar to *M. elata* and *M. nudicaulis*, with which it shares large leaves restricted to a basal rosette, and a calyx with white, pustulate scales between the lobes. It is apparently most closely related to *M. elata* from the Northern Territory, Lesser Sunda Islands and New Guinea (see Leenhouts 1962; Dunlop 1996), differing in having more or less globular capsules that are 4–6 mm long (*vs* oblong and 5–7 mm long), and staminal filaments that are mostly adnate to the tube and with the free part *c.* 0.2 mm long (*vs* only partly adnate and with free part 7–11 mm long). *Mitrasacme thedae* differs from both *M. nudicaulis* var. *nudicaulis* and var. *citrina* Dunlop in having larger leaves, a corolla tube that is prominently dilated in the upper third and 2–2.5× the width of the lower part (*vs* evenly cylindrical in *M. nudicaulis*), an open, square-shaped throat due to a small retrorse lobe in the throat (*vs* a thin, cross-shaped throat in *M. nudicaulis*), and stamens inserted just below throat (*vs* in the lower quarter of the tube in *M. nudicaulis*). *Mitrasacme thedae* and *M. nudicaulis* var. *citrina* grow intermixed on Theda Station.

The vernacular name Theda Cross-flower is suggested.

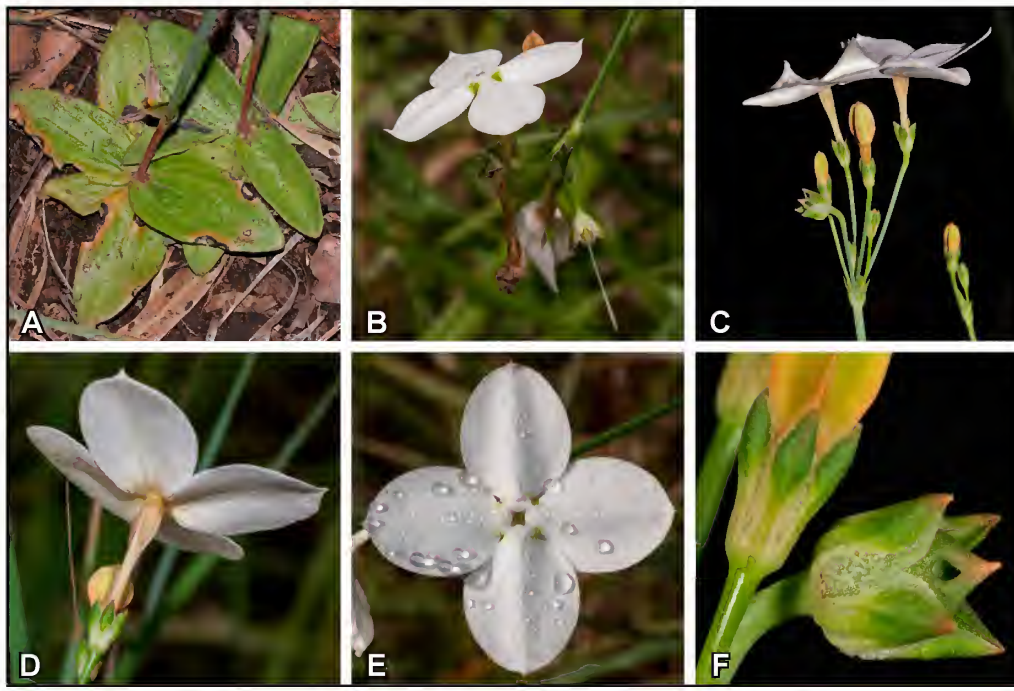

Figure 20. *Mitrasacme thedae*. A – leaf rosette showing prominent venation; B, C – inflorescence showing flowers, style, buds and fruit; D – lateral view of flower showing calyx and expanded floral tube below throat; E – flower showing ±square throat; F – calyx and fruit. Images from *R.L. Barrett* RLB 8825. Photographs by R.L. Barrett.

Menyanthaceae

Nymphoides astoniae M.D.Barrett & R.L.Barrett, *sp. nov.*

Type: Mitchell Plateau, Western Australia [precise locality withheld for conservation reasons], 25 January 2010, *R.L. Barrett & M.D. Barrett* RLB 6425 (*holo*: PERTH 08613869; *iso*: PERTH (spirit), BRI, CANB, DNA, K, MEL).

Nymphoides sp. Mitchell Plateau (R.L. Barrett & M.D. Barrett RLB 2640), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Nymphoides sp. 2 (Barrett & Barrett 2640), in N.P. Tippery & D.H. Les, *Syst. Bot.* 36: 1113 (2011).

Aquatic *annual*. *Stems* few, petiole-like, arising from the plant base, slender, flexuose, 8–15 cm long, *c.* 0.3–0.6 mm diam.; true petiole of stem leaves inconspicuous, 0.2–1.0 mm long, much shorter than the length of the blade, thicker than the stem and tapering through the inflorescence node, ±continuous with the stem, tinged or deeply coloured with maroon-purple. *Basal leaves* apparently absent. *Floating leaves*: blades entire, chevron-shaped to laterally compressed-horseshoe-shaped, deeply cordate with an open basal sinus *c.* (20–)40–70% of total blade length, of *c.* 20–100° angle, the obtuse lobes never overlapping (occasional immature leaves broadly elliptic to ovate and lacking a sinus), (6–)11–23 mm long, (5–)11–24 mm wide, usually widest just above apex of basal lobes (in least deeply lobed young leaves, widest just above the level of petiole insertion), dark green above, paler green tinged with

purple to deep maroon-purple beneath, somewhat spongy and deeply pitted beneath, the pits rounded to elliptic, 0.2–0.6 mm in longest dimension. *Inflorescence* as for the '*indica* group'; rachis not distinct; *pedicels* in a solitary cluster scarcely distanced from the subtending leaf blade by an inconspicuous petiole, 7–11 per cluster, crowded, 10–32 mm long, *c.* 0.1–0.2 mm diam.; *bract* 1 subtending each pedicel, acute, 0.6–1.5 mm long, slender, pale yellowish green or tinged with pale to deep maroon-purple. *Flowers* bisexual, (3)4(5)-partite, heterostylous, the long-styled flowers dominant. *Calyx* 1.5–2.0 mm long; lobes lanceolate to narrowly ovate, acute to subobtuse, 1.5–1.9 mm long. *Corolla* (3)4(5)-lobed, 1.7–3.1 mm long, 3.0–6.5 mm diam., white with central sections of lobes yellow; *tube* slightly shorter than the calyx, 1.0 mm long; papillae of tube crowded in a dense cluster on the petal midline just below level of throat, 0.2–0.4 mm long, the cluster united at base on a stalk *c.* 0.1 mm long; *lobes* ovate, emarginate to acute, 1.6–3.6 mm long, to 1.5 mm wide, with a transverse row of fimbriae across base and a basal tufted appendage arching inward toward style; mid-section of lobe glabrous except a sparse row of laciniae (corona) level with insertion of anther cells and well-above level of insertion of filament; side wings of lobe very narrow except at apex where 0.3–0.7 mm wide, undulate, not or very sparsely laciniate except at apex where moderately densely shortly laciniate, longest laciniae 0.3–0.6 mm long. *Stamens* with free part of filaments *c.* 0.2 mm long in long-styled flowers, 0.5–0.9 mm long in short-styled flowers (such that anthers are held well-above styles). *Anthers* oblong, 1.0–1.5× as long as broad, 0.3–0.6 mm long, 0.2–0.4 mm diam. *Gynoecium* 0.8–1.0 mm long at anthesis; ovary ellipsoid, gradually tapered into style; placentas 3 or 4, about 1/2 length of ovary, fused to ovary wall, each bearing a single ovule; *ovules* 2–4, *c.* 0.4 mm long and flattened tear-shaped at anthesis, with a thickened basal margin near the attachment from an early age; *style* (in long-styled flowers) 1.6–2.0 mm long, slender, exserted well-above tube and stigmas held above level of anthers; *stigmas* 2, with broad, erect wings, *c.* 0.4–0.5 mm long, *c.* 0.7 mm wide, divided into numerous papillae, brush-like (short-styled flowers similar except styles to 0.5 mm long, stigmas smaller, with 2 spreading wings 0.3 mm long, 0.4 mm wide, and free part of anther filaments 0.5–0.9 mm long, so that anthers are held well-above styles). *Capsule* depressed-globose, ±globose to asymmetrically depressed-turbinate, slightly exceeding calyx, 1.8–2.1 mm long, 2.0–3.5 mm diam., often distorted by seeds at maturity, thin-walled at maturity with persistent style base 0.2–0.4 mm long. *Seeds* 2 or 3 per capsule; body of seed tear-shaped, laterally compressed, acute, attached centrally at basal end, with 2 symmetrically thickened scars along lower margin, 1.9–2.0 mm long, 1.0–1.1 mm diam., 0.35–0.40 mm thick, dark grey, brown or black when mature, shiny, the surface minutely pitted, lacking tubercles; caruncle absent. (Figure 21)

Diagnostic characters. Distinguished from other *Nymphoides* Seg. species by the following combination of characters: *leaves* chevron-shaped to horseshoe-shaped at maturity with open sinuses; abaxial surfaces somewhat spongy with broad pits (but not blistered); *inflorescence* a dense cluster of pedicels subtended by a floating leaf; *corolla* white; *seeds* dark grey, brown or black, shiny, laterally compressed, tear-shaped; caruncle absent.

Other specimen examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 22 Jan. 2003, *R.L. Barrett & M.D. Barrett* RLB 2640 (PERTH).

Phenology. Flowering and fruiting only known in January, but probably occurring at least until March.

Distribution and habitat. Known from only two locations near the Mitchell River in the Kimberley region, where it grows in ephemeral, rain-fed rock pools among massive, sheeting sandstone with *Eriocaulon* sp.

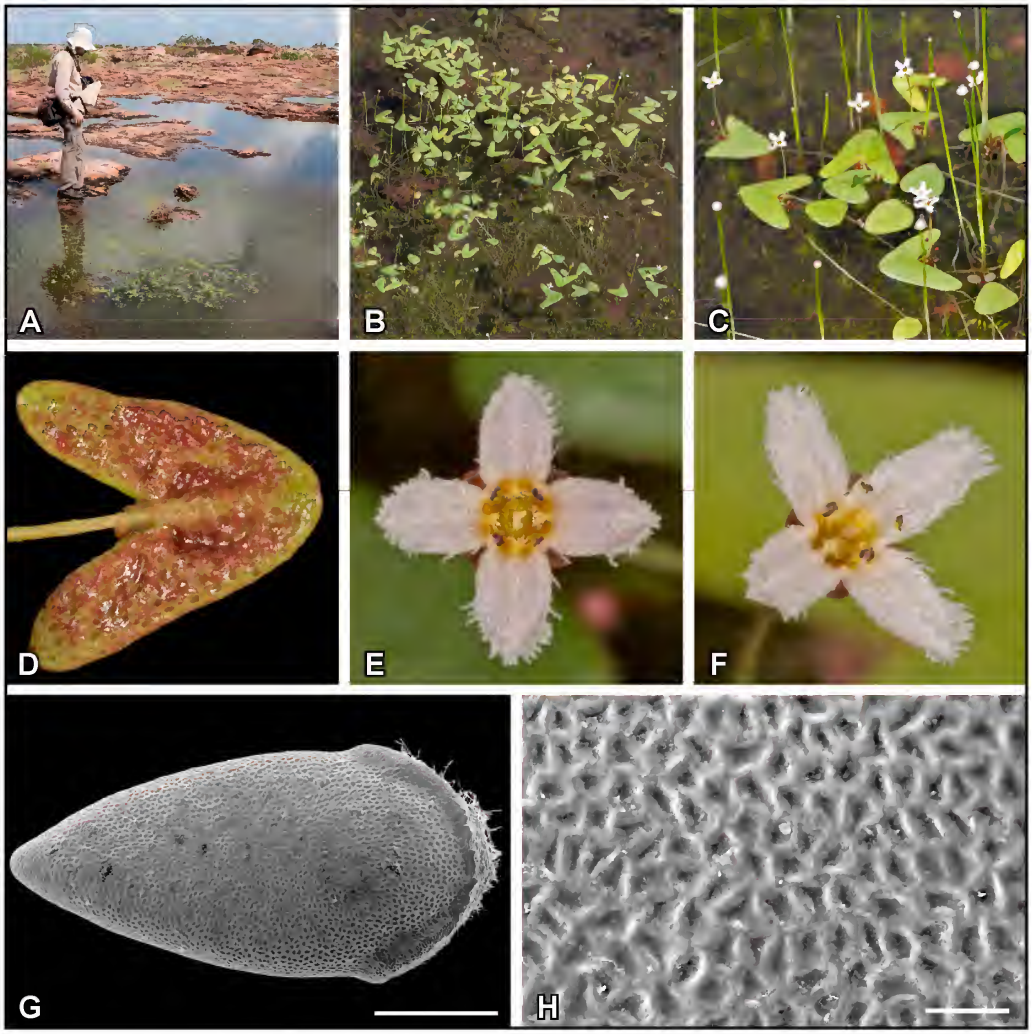

Figure 21. *Nymphoides astoniae*. A – habitat in shallow rock pool on sandstone pavement; B – habit; C – floating young and mature leaves with emergent flowers; D – lower surface of leaf; E – long-styled flower; F – short-styled flower; G – SEM of seed; H – SEM of seed surface. Scale bars = 500 µm (G); 50 µm (H). Images from *R.L. Barrett & M.D. Barrett* RLB 6425. Photographs by R.L. Barrett (A, B); M.D. Barrett (C–H).

Conservation status. *Nymphoides astoniae* is listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *N.* sp. Mitchell Plateau (R.L. Barrett & M.D. Barrett RLB 2640).

Etymology. The epithet honours Helen Aston, one of Australia's leading aquatic plant taxonomists, who revised the Australian *Nymphoides* species (e.g. Aston 1973, 1982, 1987, 1992, 2003, 2009) along with several other aquatic genera.

Notes. *Nymphoides astoniae* was referred to as '*Nymphoides* sp. 2 (Barrett & Barrett 2640)' in Tippery and Les (2011), where it grouped in a strongly supported clade with *N. furculifolia* Specht, *N. parvifolia* (Griseb.) Kuntze, *N. quadriloba* Aston and '*N.* sp. 1 (Cowie 4390)' (= *N. quadriloba*

variant of Aston 2003) in phylogenies derived from both ITS and *trn*K intron sequences. Within this clade, *N. astoniae* was unresolved in phylogenetic analyses of *trn*K intron data, but was strongly supported (100% bootstrap support) as sister to '*N.* sp. 1' by ITS data. *Nymphoides astoniae* differs from all other species in this clade in having a strongly pitted lower leaf surface, and a unique, laterally compressed and tear-shaped seed (*vs* circular in outline and subglobose to laterally compressed in the other taxa). The spongy leaves, flattened seeds and rockpool habitat are reminiscent of *N. planosperma* Aston from sandstone areas of Kakadu National Park in the Northern Territory, but the leaf abaxial surfaces are pitted (*vs* blistered in *N. planosperma*) and the seeds are tear-shaped (*vs* narrowly elliptic). Phylogenetic analyses by Tippery and Les (2011) place *N. planosperma* with *N. simulans* Aston and *N. spongiosa* Aston, well-removed from *N. astoniae*.

The vernacular name Aston's Marshwort is suggested.

Phyllanthaceae

Poranthera asybosca R.L.Barrett, *sp. nov.*

Type: [near Eneabba,] Western Australia [precise locality withheld for conservation reasons], 26 October 1993, *R. Cranfield & D. Kabay* 8958 (*holo*: PERTH 03321428).

Monoecious, erect *annual*, 20–45 mm tall. *Stems* to 9-branched, reddish green; branchlets smooth, glabrous, 0.3–0.8 mm across; leaf scars obscure. *Stipules* white, narrowly triangular, 1.0–2.2 mm long, entire. *Leaves* opposite, spaced along branchlets and crowded at apex; *petiole* 0.4–1.6 mm long, green; *blade* grading into petiole, lanceolate, acute, attenuate at base, 2.0–7.2 mm long, 0.6–1.3 mm wide, flat or margins slightly recurved at base, smooth and glabrous adaxially and abaxially, green, slightly paler below; midrib obscure adaxially, slightly raised abaxially. *Racemes* solitary, dense, terminal, umbel-like; *rachis c.* 1 mm long; *bracts* narrowly obovate, 1.7–2.5 mm long, 0.8–1.0 mm wide, acute to obtuse. *Male flowers* with a pedicel *c.* 2 mm long; *calyx tube c.* 0.5 mm long; *calyx lobes* 5, pink to greenish, lanceolate, acute, *c.* 1 mm long, *c.* 0.2 mm wide, concave or convex; *petals* 5, pale pink, erect, ovate, obtuse, *c.* 2.5 mm long, *c.* 0.4 mm wide; glands obscure; *stamens* 5, filaments *c.* 2 mm long, straight; *anthers c.* 0.25 mm long; *rudimentary ovary* a minute hemispherical dome. *Female flowers* with a pedicel to 2.5 mm long, extending to 3.1 mm long in fruit; *calyx lobes* 5, green to reddish, lanceolate to narrowly oblong, acute, *c.* 0.5 mm long, 0.2–0.3 mm wide, concave to convex; *petals* obscured by sepals; *ovary* depressed-globose, *c.* 0.5 mm across, 6-lobed, emarginate distally, rough; *styles* 3, appearing 6, *c.* 0.3 mm long, divided almost to base, slender. *Capsule* depressed-globose, 1.5–2.0 mm long, 2–3 mm diam., prominently 6-lobed, emarginate distally, rough and wrinkled. *Seeds* broadly wedge-shaped to sub-ovoid, *c.* 0.45 mm long, *c.* 0.40 mm wide, *c.* 0.35 mm deep; testa with interlocking ovoid domes that bear numerous secondary transverse ridges (cerebriform), pale brown, lacking a waxy coating. (Figure 22)

Diagnostic characters. Distinguished from other *Poranthera* Rudge species by the following combination of characters: *stems* reddish green; *leaves* with indistinct petioles 0.4–1.6 mm long; *stipules* entire; *seeds* with a regular cerebriform pattern.

Other specimen examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 28 Sep. 2012, *R.L. Barrett* RLB 7813 (PERTH).

Phenology. Flowering and fruiting recorded from September to October.

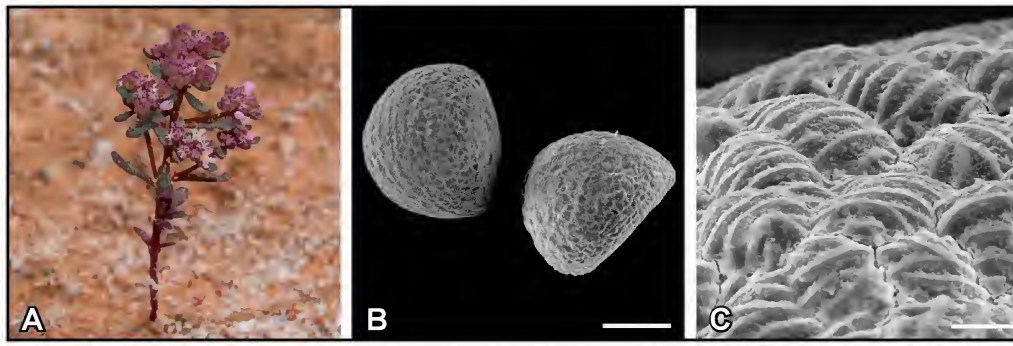

Figure 22. *Poranthera asybosca*. A – flowering plant; B – SEM of seed; C – SEM of seed surface. Scale bars = 200 μm (B); 10 μm (C). Images from *R.L. Barrett* RLB 7813 (A) and *R. Cranfield & D. Kabay* 8958 (B, C). Photographs by R.L. Barrett.

Distribution and habitat. Only known from a small area between Badgingarra and Eneabba. Open kwongan shrubland on white sand over laterite.

Conservation status. *Poranthera asybosca* is to be listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.).

Etymology. The epithet is a contraction of letters from the Australasian Systematic Botany Society, terminated by *-a*, acknowledging the work of the society in promoting plant systematics in Australia. The second known collection of this species was made during the post-conference field trip of the Australasian Systematic Botany Society conference held in Perth in 2012.

Notes. Previously confused with *P. microphylla* Brongn. which is distinctive in having a white, waxy coating on the seeds (absent in *P. asybosca*), but probably more closely allied to *P. leiosperma* Halford & R.J.F.Hend. which differs in having smooth rather than cerebriform seeds (Halford & Henderson 2005).

The vernacular name Cerebriform-seeded Poranthera is suggested.

Poaceae

Triodia basitricha M.D.Barrett, *sp. nov.*

Type: [near] Mount Florence Homestead, Western Australia [precise locality withheld for conservation reasons], 11 May 1996, *A.A. Mitchell* PRP 1035 (*holo*: PERTH 04995619; *iso*: CANB).

Triodia sp. Millstream (A.A. Mitchell PRP 207), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 7 July 2014].

Tussock-forming *perennial*, non-resinous or weakly resinous, not obviously stoloniferous; *tussocks* compact, *c.* 30–40 cm high, 40–60 cm diam.; *flowering culms* 35–70 cm high. *Culm internodes* all short (never elongated as in *T. claytonii* Lazarides), <1 cm long and completely obscured by subtending foliage, straw-coloured to dark red-brown, glabrous; aerial roots not found. *Leaf sheaths* 2.6–4.0 mm wide near apex, sparsely to moderately pilose on surface with hairs 1.1–2.2 mm long, not resinous, straw-coloured, strongly nerved; margins glabrous; margins of orifice truncate or sub-auriculate, with a dense fringe of hairs, the longest hairs 2.2–4.0 mm long. *Ligule* a dense fringe of hairs *c.* 0.25 mm

long; *pseudopetiole* not distinct. *Leaf blades* flattened-V-shaped when fresh, conduplicate and tightly in-rolled when dry, initially straight but becoming curled in older and dead leaves, 13.0–27.5 cm long, 0.5–0.9 mm diam. when rolled (unrolled leaves not seen), when fresh relatively soft, weakly pungent, glabrous abaxially, adaxial surface densely papillose, often resinous over abaxial surface, bright green, drying pale yellow-green; stomatal grooves on abaxial surface confined to central part, 4 (2 either side of small midrib), equally spaced, grooves absent on marginal *c.* 1/3 but finely obscurely ribbed, stomatal grooves on abaxial surface 7 or 8 each side of midrib; margins minutely scaberulous with prickle hairs <0.1 mm long. *Panicle* 7–15 cm long, 2–4 cm wide; branches openly racemose (or extreme base of longest branches very shortly ternate), moderately dense to loose, lanceolate to narrowly triangular, glabrous except minute tufts of hairs *c.* 0.3 mm long in branch axils, non-resinous; primary axis angular to ribbed or flattened; longest basal panicle branches 2.7–8.0 cm long, terete to angular or weakly flattened, with 4 or 5 loosely arranged, ±uniform-sized spikelets, which are 4.5–11.5 mm apart (measured from base of pedicels) and partly overlapping; basal pedicels (on longest lower panicle branches) 2.0–2.5 mm long, 0.11–0.13 mm diam., filiform, becoming slightly thicker just below spikelet, terete, minutely scabrous; terminal pedicel 5.5–8.0 mm long. *Spikelet* 7–10 mm long, 3–4 mm wide (excluding awns), loosely 3- or 4-flowered with 2 or 3(?4) fertile florets (apparently 1 or 2 sterile florets at apex, but these possibly merely immature), narrowly oblong or narrowly lanceolate; lowest rachilla internode *c.* 2.2 mm long, *c.* 0.12 mm diam., minutely scabrous; spikelets disarticulating above glumes and at rachilla internodes at maturity. *Lower glume* 10.0–12.5 mm long, 3.6–3.8 mm wide, lanceolate, acuminate, sometimes very slightly aristulate, but lacking awns or a distinct arista, equal to or longer than the combined spikelet florets (excluding awns), scarious, sometimes with narrow membranous margins, with minute scabrosities <0.05 mm long over whole surface, 3(sub-5)-nerved, the midnerve slightly raised, laterals scarcely raised, glabrous on margins. *Upper glume* inserted *c.* 0.5 mm above lower glume, 11–13 mm long, similar to and subequal to (usually very slightly longer than) lower glume, subequal to or slightly longer than the combined florets. *Lowest lemma* 15.0–16.5 mm long including lobes, oblanceolate, strongly bitextured (lower part indurated, upper part membranous-chartaceous, the underside with a thickened callosity at the junction), deeply 3-lobed, 3-awned; body 3.7–4.5 mm long including callus, the indurated part with sparse to dense, appressed (sometimes some slightly lifting) hairs 0.2–0.3 mm long, not visibly nerved, the membranous part with 3 groups of 3 obscure nerves radiating into lobes and awns; midlobe 10–12 mm long (including awn), narrowly triangular at base narrowing into an awn, slightly to distinctly narrower than lateral lobes; lateral lobes 7–8 mm long (including awn), narrowly triangular at base narrowing into an awn, margins with a narrow, membranous wing; *callus* 0.20–0.25 mm long, slightly curved, attached obliquely, blunt, obtuse in face view, white-bearded, the longest hairs *c.* 0.5 mm long. *Upper lemmas* similar to but smaller than lowest lemma. *Palea* of basal lemma distinctly longer than lemma body, 5.1–5.5 mm long, 0.6–0.8 mm wide, narrowly oblanceolate, 2-keeled, bitextured, lower part indurated and appressed-hairy, upper part translucent-membranous, hairs becoming less dense toward the glabrous apex, apex distinctly bifid with acute lobes 1.3 mm long; keels raised but not winged, keel margins densely scabrous; flaps *c.* 0.10–0.15 mm wide, broadest in upper membranous part, narrower than 1/2 width of the palea body and not overlapping, entire. *Anthers* 3, 2.3–2.5 mm long, exserted at maturity. *Styles* 2, *c.* 1.7 mm long. *Caryopsis* not seen. (Figure 23)

Diagnostic characters. Distinguished from *T. bitextura* Lazarides by the following combination of characters: *leaves* with sheaths sparsely to moderately pilose and margins glabrous; *leaf blades* non-resinous or weakly resinous, 'soft'-type, lacking stomatal grooves on lateral abaxial surfaces; *lemmas* awned, body bitextured, appressed-hairy in lower 1/2.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 12 Mar. 2013, *M.D. Barrett & B.M. Anderson* MDB 4023 (PERTH); 31 Mar. 1994, *A.A. Mitchell* PRP

207 (CANB, PERTH); 2 Apr. 1995, *A.A. Mitchell* PRP 258 (CANB, PERTH); 7 Aug. 2007, *E. Thoma* ET 1325 (PERTH); 26 July 2002, *S. van Leeuwen* 5071 (PERTH).

Phenology. Fertile collections have been made between March and August, but core flowering and fruiting is most likely from January to March.

Distribution and habitat. Occurs in the western and central Pilbara region of Western Australia, and also from Barlee Range Nature Reserve south of the Pilbara. Collections are all from the slopes or crests of rocky hills, which may indicate a more 'refugial habitat' requirement, as is common to several other Pilbara 'soft' *Triodia* R.Br. species such as *T. biflora* Lazarides, *T.* sp. Robe River (M.E. Trudgen et al. MET 12367) and *T.* sp. Karijini (S. van Leeuwen 4111).

Conservation status. *Triodia basitricha* is listed by Jones (2014) as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *T.* sp. Millstream (A.A. Mitchell PRP 207). It is known from seven locations and appears to occur in isolated patches, albeit across a relatively large area of the Pilbara. Collection notes report it as common (*A.A. Mitchell* PRP 207; *S. van Leeuwen* 5071) or sparse (*A.A. Mitchell* PRP 258).

Etymology. The epithet is from the Greek *basis* (base) and *trichos* (hair) and refers to the hairy leaf sheaths.

Notes. *Triodia basitricha* was treated as part of a broad concept of *T. bitextura* by M. Lazarides (*in. sched.*), by virtue of the shared bitextured lemma and palea, awned lemma lobes, and short, blunt (obtuse) calli. Specimens have since been determined either as *T. bitextura* or *T. schinzii* (Henrard) Lazarides. *Triodia basitricha* differs from *T. bitextura* in having sparsely to moderately densely hairy (pilose) leaf sheath surfaces (in all other forms of *T. bitextura* the sheath surfaces are glabrous, or occasionally minutely tomentose near the nodes), and leaf sheath margins that are glabrous except at the sheath orifice (in *T. bitextura* they are glabrous or pilose). It differs from *T. schinzii* and *T. helmsii* (C.E.Hubb.) Lazarides in having hairy leaf sheaths, smaller glumes, and blunt calli (acute in *T. schinzii* and *T. helmsii*).

The only other Pilbara taxon with a bitextured lemma is *T.* sp. Mt Ella (M.E. Trudgen 12739), which differs in having glabrous leaf sheath surfaces and strongly resinous foliage (not or weakly resinous in *T. basitricha*). The two taxa have disjunct distributions, with *T.* sp. Mt Ella occurring in the eastern Hamersley Range and *T. basitricha* to the west and north.

Triodia basitricha comprises a distinct lineage in an (unpublished) ITS phylogeny (>1,000 specimens sampled, including six samples of *T. basitricha*). The type of *T. bitextura* is from islands in the Gulf of Carpentaria. Although authentically topotype material has not yet been sequenced, ITS (and ETS for some) nrDNA sequences have been obtained for numerous other collections throughout northern Australia. *Triodia bitextura* is clearly polyphyletic in trees reconstructed from these regions. All other lineages in the *T. bitextura* complex are phylogenetically remote from *T. basitricha* (M.D. Barrett, unpubl. data).

The vernacular name Pilbara Curly Spinifex is suggested.

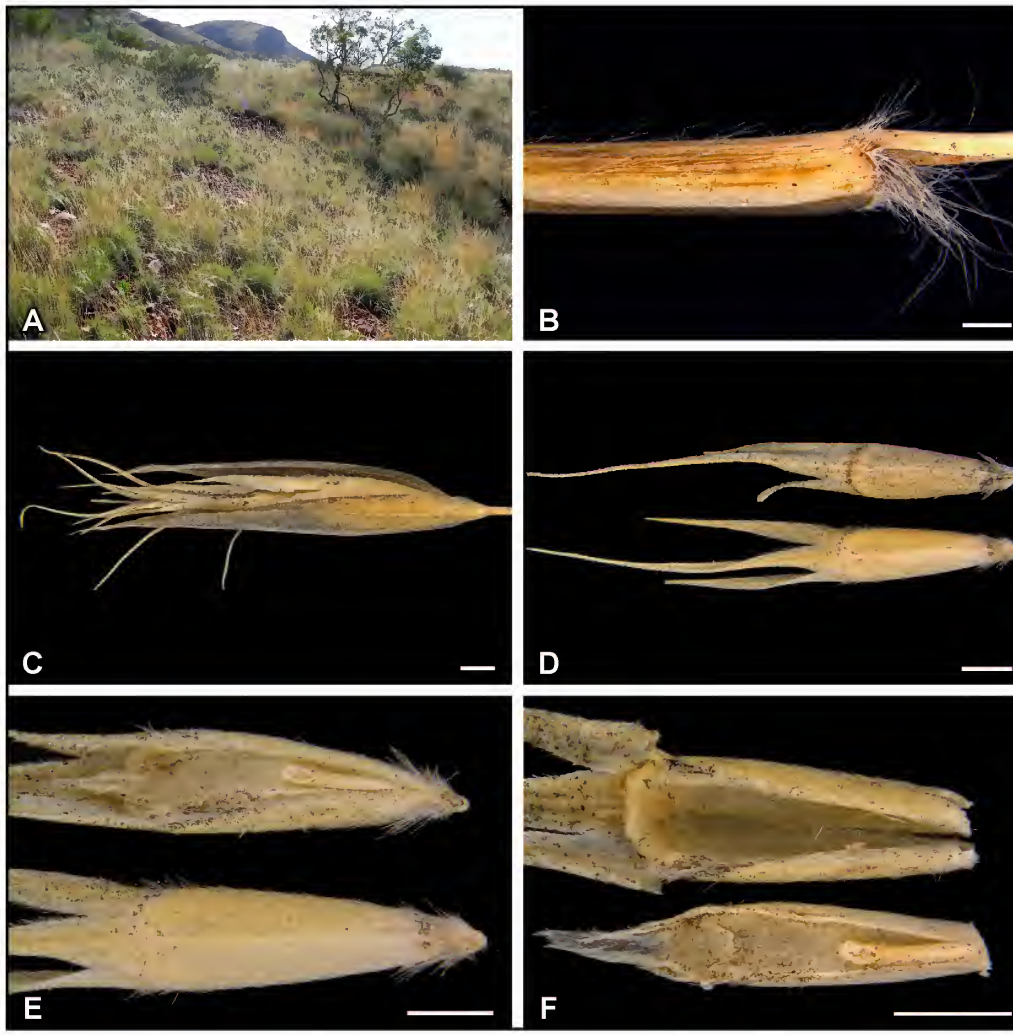

Figure 23. *Triodia basitricha*. A – habitat and habit on rocky hill slope; B – junction of leaf sheath and blade showing long hairs on the orifice, and diagnostic sparse hairs on the sheath surface; C – spikelet; D – lemmas; E – upper (top) and lower lemma; F – underside of lower spikelets with palea in situ (lower) and palea removed (upper) to expose the thickened callosity at the texture junction. Scale bars = 2 mm (B–D); 1 mm (E, F). Images from *M.D. Barrett & B.M. Anderson* MDB 4023. Photographs by M.D. Barrett.

Triodia celsa M.D.Barrett, *sp. nov.*

Type: Prince Regent Nature Reserve [National Park], West Kimberley Region, Western Australia [precise locality withheld for conservation reasons], 30 March 2010, *M.D. Barrett & R.L. Barrett* MDB 2952 (*holo*: PERTH08613990; *iso*: BRI, CANB, DNA, K, NSW, NY, PERTH 08615071).

Tussock-forming *perennial*, non-resinous, not conspicuously stoloniferous; *tussocks* dense, 0.6–0.9 m high, 0.5–0.8 m diam.; *flowering culms* 1.1–1.4 m high. *Culm internodes* mostly short, a few elongated, dark red-brown, sub-shiny, glabrous; longest internodes to 70 mm long; aerial roots absent. *Leaf sheaths* 3.5–6.0 mm wide near apex, glabrous on surface, non-resinous, straw-coloured, many-nerved; margins glabrous in upper *c.* 1/2, pilose with hairs 2–6 mm long in basal *c.* 1/2; margins of orifice broadly

rounded, ±truncate or shortly auriculate with broad shallow auricles *c.* 0.1–0.3 mm long, with hairs 2–5 mm long. *Ligule* a dense fringe of hairs with a thin, membranous part *c.* 0.1 mm long, the hairs 0.2–1.0 mm long, longer in central zone and shorter near margins; *pseudopetiole* absent. *Leaf blades* ±flat when fully hydrated, conduplicate and tightly in-rolled when stressed or dried, (3–)17–37 cm long, 2.0–2.5 mm wide when unrolled, flexible, shortly pungent with a dark mucro 0.4–1.1 mm long, glabrous abaxially, adaxial surface glabrous or sometimes pilose along adaxial veins in basal 1 cm, non-resinous, green; stomatal grooves on abaxial surface clustered centrally, 4 (2 grooves either side of a moderately broad midrib), grooves absent on lateral surfaces, the lateral surfaces smooth to very obscurely longitudinally ribbed; margins with sparse, blunt, appressed prickle hairs 0.01–0.05 mm long (sometimes a few sharp, erect ones at base to 0.1 mm long). *Panicle* (7.5–)22–29 cm long, 2.5–4.0 cm wide, open, narrowly lanceolate in outline, lacking hairs in axis and divisions, non-resinous; branches in 3s throughout, only racemose at apex where terminal 3 or 4 spikelets directly inserted on main axis, all axes minutely antrorsely scabrous; primary axis angular in TS; longest basal branches 46–80 mm long, lenticular to irregularly angular in TS, with 7–9 regularly biseriate, non-secund spikelets which are 6–11 mm apart (measured from base of pedicels) and mostly not overlapping, but some slightly overlapping toward the apex; basal pedicels (on longest lower panicle branches) 5–8 mm long, decreasing in length toward apex where 1.5–2.5 mm long, *c.* 0.15–0.30 mm wide, lenticular to flattened in TS with angular margins; terminal pedicel 3–6 mm long. *Spikelet* 5.0–6.0 mm long, 2.0–3.0 mm diam., 3–5-flowered (3 or 4 florets fertile, 1 at apex possibly sterile), narrowly elliptic to narrowly ovate or ovate; lowest rachilla internode 0.2–0.3 mm long, *c.* 0.2 mm thick, glabrous; spikelets disarticulating above glumes as a unit, or also above first rachilla at maturity. *Lower glume* 3.5–4.5 mm long, 1.1–1.2 mm wide in face view (natural curvature), 1.0 mm wide in side view, elliptic, apex acute, minutely mucronulate (mucro to 0.25 mm long), minutely erose or minutely 3-lobed (lateral lobes shorter than central mucro, up to *c.* 0.1 mm long), not awned, slightly shorter than the combined florets *in situ*, chartaceous, minutely scabrous all over surface (the projections slightly longer on midnerve and margins), 3-nerved, the midnerve most prominent, thin, slightly raised, lateral nerves scarcely raised; margins entire, glabrous. *Upper glume* inserted 0.2–0.3 mm above lower, 3.8–4.5 mm long, similar to lower glume except apex always 3-lobed (midlobe 0.2–0.4 mm long, thin and often mucronate, lateral lobes shorter to subequal to the midlobe, broader than midlobe and ±flattened), slightly shorter and not reaching or slightly exceeding apex of lower glume, shorter than combined florets. *Lowest lemma* 4.4–5.5 mm long including lobes, narrowly ovate to ±elliptic (ovate if flattened), 3-lobed, not awned; body 3.0–3.5 mm long, chartaceous-indurated, equally thick throughout (margin not membranous), with a sparse to moderately dense indumentum of colourless, ascending hairs to 0.5 mm long arranged in distinct rows along obscure nerves over basal 3/4–4/5, the nerves 9 in 3 groups of 3 nerves (the central nerve in each group obscure, the laterals very obscure), the main midnerve prominent and weakly keeled; lobes 20–30% of the total lemma length, with nerves ±equally spaced, obscure; midlobe 1.0–2.1 mm long, narrowly triangular and acuminate, a little narrower than the laterals especially near base; lateral lobes 0.6–1.4 mm long and less than 1/4 to subequal the midlobe, margins not winged or membranous, similar in texture to body; *callus* 0.05–0.10 mm long, attachment slightly oblique, blunt, obtuse in face view, glabrous or sometimes with a few hairs on lateral margins just above callus on lemma body. *Upper lemmas* each smaller than the one below. *Palea* of basal lemma slightly longer than lemma body, 3.5–4.0 mm long, *c.* 0.9 mm wide, 2-keeled, membranous, not bitextured, narrowly obovate, blunt to erose or notched, glabrous; keels prominent, with a distinct but narrow wing *c.* 0.05–0.10 mm wide, minutely scabrous on wing margin, which runs out just before membranous apex; flaps 0.15–0.30 mm wide, much narrower than body and not overlapping, membranous, entire. *Anthers* 3, 2.0–2.5 mm long. *Styles* 2, *c.* 1.8 mm long. *Caryopsis* 1.8–2.0 mm long, 0.7–0.8 mm wide, L:W ratio 1.8–2.5:1, narrowly elliptic, obtuse at apex, acute at base, terete or slightly dorsiventrally flattened in TS, pale reddish straw-coloured, base of styles slightly thickened; hilum 0.5–0.8 mm long. (Figure 24)

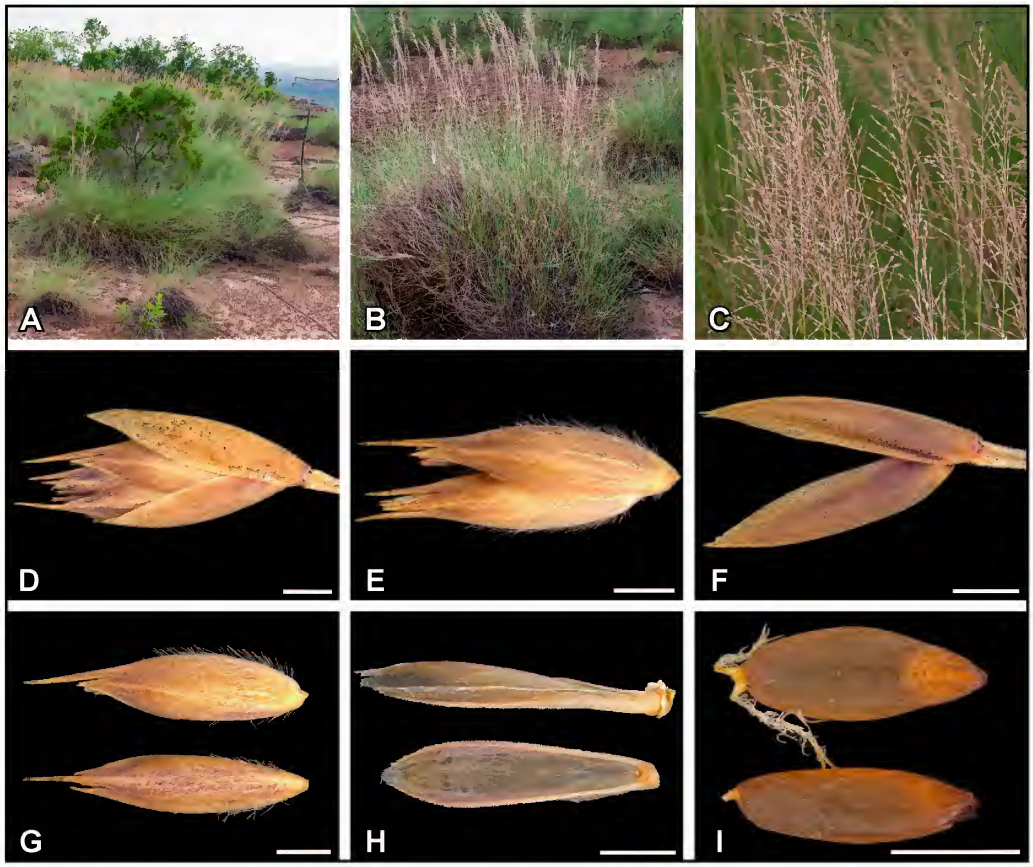

Figure 24. *Triodia celsa*. A – habitat on sandstone mesa summit; B – habit, C – inflorescence; D – spikelet; E – floret; F – glumes; G – side and top view of lemma; H – side and top view of palea; I – side and top view of caryopsis. Scale bars = 1 mm. Images from *M.D. Barrett & R.L. Barrett* MDB 2952. Photographs by R.L. Barrett (A–C); M.D. Barrett (D–I).

Diagnostic features. Distinguished from other *Triodia* species by the following combination of characters: *leaf blades* (3–)17–37 cm long, lacking stomatal grooves on the adaxial marginal *c.* 1/3 ('soft'-type anatomy), non-resinous; *inflorescence* a panicle; longest branches 46–80 mm long; panicle axis and branches densely minutely antrorsely scabrous all over, giving the plant a rough sandpaper texture when stroked against the grain; *spikelets* with 3–5 florets; *callus* blunt, very small, glabrous; *lemma* with hairs distinctly arranged in rows along the nerves, 3-lobed, not awned, midlobes 1.0–2.1 mm long, acute; *palea* membranous, not bitextured, with narrow wings 0.05–0.10 mm wide; *caryopsis* elliptic, terete or slightly dorsiventrally flattened, 1.8–2.0 mm long.

Other specimens examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 29 Aug. 1974, *A.S. George* 12786 (PERTH); 30 Mar. 2010, *M.D. Barrett & R.L. Barrett* MDB 2953 (MEL, PERTH); 30 Mar. 2010, *M.D. Barrett & R.L. Barrett* MDB 2954 (NSW, PERTH).

Distribution and habitat. Known from a single location in Prince Regent National Park. Occurs amongst stones on the flat or gently undulating plateau of a sandstone mesa, in sandy soils and low, open *Acacia* woodland.

Phenology. Fertile material has been collected in March and August, but the latter record was during an unusual year in which it rained most months. In most years there is very little or no rainfall between May and September and therefore flowering at that time is uncommon.

Conservation status. *Triodia celsa* is to be listed as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). At the single known site it is a dominant understorey plant over several hectares. It has not been found in surrounding basalt lowlands (where habitat is unsuitable) or on nearby sandstone mesas. It has the potential to be impacted by inappropriate fire regimes.

Etymology. The epithet is from Latin *celsus* (upraised, high, lofty) and refers to the elevated habitat at the type locality.

Notes. The differences between the Pungens and Procera groups of Lazarides *et al.* (2005) are subtle, and *T. celsa* straddles the group definitions in some characters (lemma lobe length, and the distribution of hairs on the callus and lemma). It must therefore be contrasted with species in both groups. *Triodia celsa* is perhaps most similar to taxa in the Pungens group, but can be distinguished by its non-resinous leaves, sheaths and panicles (*vs* strongly resinous, at least on the leaves). It is most similar morphologically to *T. pungens* R.Br. and *T. mitchellii* Benth., differing in being non-resinous (*vs* strongly to moderately resinous) and with a glabrous callus 0.05–0.10 mm long (*vs* 0.2–0.3 mm long and hairy, at least laterally). *Triodia celsa* differs from *T. epactia* S.W.L.Jacobs and *T. marginata* N.T.Burb. in lacking wings on the lateral margins of the outer lemma lobes (*vs* wings present), and from *T. latzii* Lazarides and *T. hubbardii* N.T.Burb. by its 0.05–0.10 mm long, glabrous callus (*vs* 0.3–0.5 mm long and bearded laterally). *Triodia celsa* differs from *T. longiloba* Lazarides in having paniculate inflorescences (*vs* racemose or sub-racemose) and lemma (mid)lobes that are 1.0–1.9 mm long (*vs* 2.5–5.5 mm long).

Triodia celsa differs from *T. procera* R.Br. (which can be non-resinous like *T. celsa*) in having lemmas hairy on the body (*vs* glabrous) and with longer (mid)lobes (1.0–1.9 mm long *vs* to 0.7 mm long), and a Kimberley distribution (*vs* north-east Northern Territory and Queensland). *Triodia celsa* differs from most members of the Procera group (other than *T. procera*, i.e. *T. biflora*, *T. burbidgeana* S.W.L.Jacobs, *T. microstachya* R.Br. and *T. radonensis* S.W.L.Jacobs) in having non-resinous foliage (*vs* resinous), and hairy lemmas with (mid)lobes 1.0–1.9 mm long mm long (*vs* glabrous and to 1 mm long). *Triodia celsa* differs from *T. cunninghamii* Benth. in having a lemma body with sparse to moderately dense hairs arranged in distinct rows along obscure nerves (*vs* densely and extensively hairy) and lemma lobes that are mostly distinctly unequal (*vs* lobes more or less equal). *Triodia celsa* differs from *T. stenostachya* Domin in having lemma lobes that are acute to acuminate but lacking a distinct bristle-like arista (*vs* central lobe with a distinct bristle-like arista).

A.S. George 12786 was previously identified by M. Lazarides as *T.* aff. *plectrachnoides* N.T.Burb. *Triodia celsa* superficially resembles *T. plectrachnoides* in the non-resinous foliage, long leaf blades and similar lemma lobe length, but the leaf anatomical type is 'hard' in *T. plectrachnoides*. The work of Mant (1998), Mant *et al.* (2000) and Toon *et al.* (2015) demonstrates that leaf anatomy is more phylogenetically informative than lemma lobing. The similarity to *T. plectrachnoides* is therefore superficial, and closest relatives should be sought amongs the 'soft' species of *Triodia*.

In Lazarides *et al.* (2005), *T. celsa* would key to *T. roscida* N.T.Burb. in Group 4 (assuming the longest pedicels are allowed to be as small as 5–8 mm long at step 9 in the group key, but clearly not matching

the alternative, up to 3 mm long and uniform in size), from which it is immediately distinguished by having long leaves with 'soft' type anatomy (*vs* blades to 15 cm long and 'hard' type), and lemma hairs that are relatively sparse and grouped in lines along the nerves (*vs* hirsute over most of the lemma body). Note that the report of hairs only on the midline and near the base of the lemma in *T. roscida* in Lazarides *et al.* (2005) refers to a different, undescribed taxon; *T. roscida s. str.* has hairs more or less uniformly distributed over most of the lemma body (Burbidge 1953).

With the addition of unreported variation (including new taxa) from the north-west of Australia, the keys presented in Lazarides (1997) and Lazarides *et al.* (2005), and also Simon and Alfonso (2011–) no longer allow adequate discrimination between many *Triodia* taxa and also the groups of Lazarides *et al.* (2005). Descriptions of further taxa and a revised key are in preparation by one of us (MDB).

The vernacular name Mount Trafalgar Spinifex is suggested.

Triodia diantha M.D.Barrett, *sp. nov.*

Type: Phillips Range, Marion Downs Station, Western Australia, 28 March 2010, *G. Armstrong s.n.* (*holo*: PERTH 08615098).

Hummock or tussock-forming *perennial*, resinous, stolons very short and not protruding from tussock; *tussocks* loose, *c.* 1 m high; *flowering culms c.* 1.0–1.5 m high. *Culm internodes* (basal-most nodes not seen) wiry, elongated, 4–9 cm long, red-brown, glabrous. *Leaf sheaths* 2–5 mm wide near apex, glabrous on surface, resinous, straw-coloured, with the nerves ±equally spaced; margins glabrous except at orifice; margins of orifice not auriculate, with hairs 1.5–3.0 mm long. *Ligule* with a very short membranous part below a dense fringe of hairs 0.6–0.9 mm long; *pseudopetiole* distinct or not, when distinct 1–4 mm long. *Leaf blades* flat in TS when fresh and maximally expanded, conduplicate and tightly in-rolled when dry, 9–22 cm long, 0.9–1.7 mm wide when flattened, flexible, glabrous, weakly pungent (long-attenuate) for 1.0–1.5 mm, weakly to moderately resinous, green; stomatal grooves on abaxial surface restricted to central region, 4, in 2 close pairs either side of a broader smooth midrib, stomatal grooves absent on lateral surfaces, but may be very finely and obscurely longitudinally grooved; margins sparsely scabrid with trichomes 0.05–0.15 mm long. *Panicle* 9–11 cm long, 1–5 cm wide, linear to ovate when branches spread, loose; branchlets in 3s in basal part, not becoming racemose at apex; axes minutely scabrous (prickle hairs *c.* 0.5 mm long), not resinous; primary axis angular to slightly flattened; longest basal panicle branches 30–50 mm long, the axes terete, angular or in places flattened, with 5–7 loosely arranged spikelets which are 6–13 mm apart (measured between panicle branch nodes) and not overlapping; basal pedicels (on longest lower panicle branches) 4–13 mm long, significantly decreasing in length along branch toward apex (where 0.6–3.0 mm long); terminal pedicel 6–8 mm long; all pedicels ±filiform, *c.* 0.1–0.2 mm diam., terete to angular or slightly flattened just below spikelet, with thin scabrous projections *c.* 0.05–0.10 mm long, the longest near pedicel apex. *Spikelet* 3.0–5.0 mm long, 1.7–2.4 mm diam., uniformly 3-flowered but appearing 2-flowered (the lower 2 florets fertile and well-developed, with an additional minute, long-stalked vestigial sterile floret only visible upon dissection), narrowly to moderately ovate; lowest rachilla internode 0.2–0.3 mm long, *c.* 0.2 mm thick; second rachilla internode 1.5 mm long, much longer than first and filiform (*c.* 0.02 mm diam.), bearing the vestigial floret; spikelets disarticulating above rachilla internodes at maturity. *Lower glume* 2.7–3.0 mm long, 1.6–2.5 mm wide when flattened (*c.* 1.0 mm wide unflattened), broadly ovate, obtuse to acute, not apiculate or shortly so, not awned, shorter than to shortly exceeding upper lemma body but not reaching apex of lemma lobes, moderately indurated, glabrous, 3-nerved, the midnerve moderately raised, lateral nerves not raised; margins inconspicuously minutely fimbriate. *Upper glume* inserted 0.3 mm above lower, 2.7–3.3 mm long, similar to lower

but apex obtuse, more frequently and more abruptly apiculate (when present the apiculus to 0.25 mm long), not quite or shortly exceeding lemma body but not reaching apex of lemma lobes. *Lowest lemma* 3.1–4.4 mm long including lobes, elliptic to narrowly elliptic in face view, 3-lobed but not awned; body 2.6–3.1 mm long, mostly indurated, not obviously bitextured but a with a subtle change in texture and colour just below the lobe sinus, with appressed hairs to 0.5 mm long especially in the lower *c.* 2/3 in a broad zone around the midline, obscurely 3-nerved (most distinctly visible from below), lateral margins near lobes not winged; lobes narrowly triangular, acute, ±chartaceous, obscurely 3-nerved; midlobe 1.3–1.4 mm long; lateral lobes 0.8–1.0 mm long, slightly broader than the midlobe; *callus* 0.1–0.2 mm long, a small knob or rounded thickening, attachment shallowly oblique, blunt, with a thin continuous band of hairs 0.6–0.7 mm long (bare midline absent). *Second lemma* slightly shorter than lowest one. *Third lemma* vestigial, knob-like, *c.* 0.45 mm long, falling attached to rachis with second palea and hidden by it. *Palea* of basal lemma longer than lemma body, reaching *c.* 1/2 way along the lemma lobes, 3.3–3.7 mm long, *c.* 0.9 mm wide with flaps folded underneath, 2-keeled, ±chartaceous becoming membranous-translucent near base, lanceolate, acute, entire, minutely hairy in upper 1/2 on abaxial surface and minutely hairy only at apex on adaxial surface; keels prominent, thickened and raised but not winged, *c.* 0.05 mm wide, scabrous in upper 2/3; flaps 0.1–0.3 mm wide (broadest near base), *c.* 1/4 body width and not overlapping, membranous, entire. *Anthers* 3, 1.8–1.9 mm long. *Styles* 2, *c.* 1.5 mm long. *Caryopsis* not seen. (Figure 25)

Diagnostic features. Distinguished from other *Triodia* species by the following combination of characters: *culms* with upper nodes elongated, red-brown; *leaves* lacking stomatal grooves on the adaxial outer margins ('soft'-type anatomy), resinous, flexible; *pedicels* unequal, markedly decreasing in size along panicle branches; *florets* apparently 2 per spikelet, subequal (resembling the 2 equal florets of *Eriachne* R.Br.), with a vestigial, long-stalked third spikelet; *lemma* body appressed-hairy, lacking a sharp transverse line of change in texture, 3-lobed, the lobes acute, erect, subequal, with laterals slightly shorter than midlobe; *callus* hairy.

Other specimens examined. Known only from the type collection.

Distribution and habitat. Known only from the Phillips Range in the west Kimberley, where it grows on the steep slope of a sandstone escarpment. Associated vegetation is unknown.

Phenology. The only known specimen was in flower in late March.

Conservation status. *Triodia diantha* is to be listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.).

Etymology. The epithet is from the Greek *di-* (two-) and *anthos* (flower), and refers to the two fertile florets per spikelet.

Notes. The spikelet composition of this species, with two fertile florets and a long-stalked vestigial one, is uniform on all flowers of the type specimen, regardless of degree of maturation. The spikelet condition is not an aberration due to drought conditions, since the anthers of many flowers are becoming exposed, while in other flowers the styles are fully expanded; in addition the terminal rachilla internode is fully expanded. Drought conditions in other *Triodia* species have been observed to truncate development, preventing anthers and styles from being exserted, aborting the terminal florets (as fully-formed but miniature version of the lower floret, not as vestigial knobs) and have never been observed causing abnormal rachilla elongation (instead drought appears to limit the development of

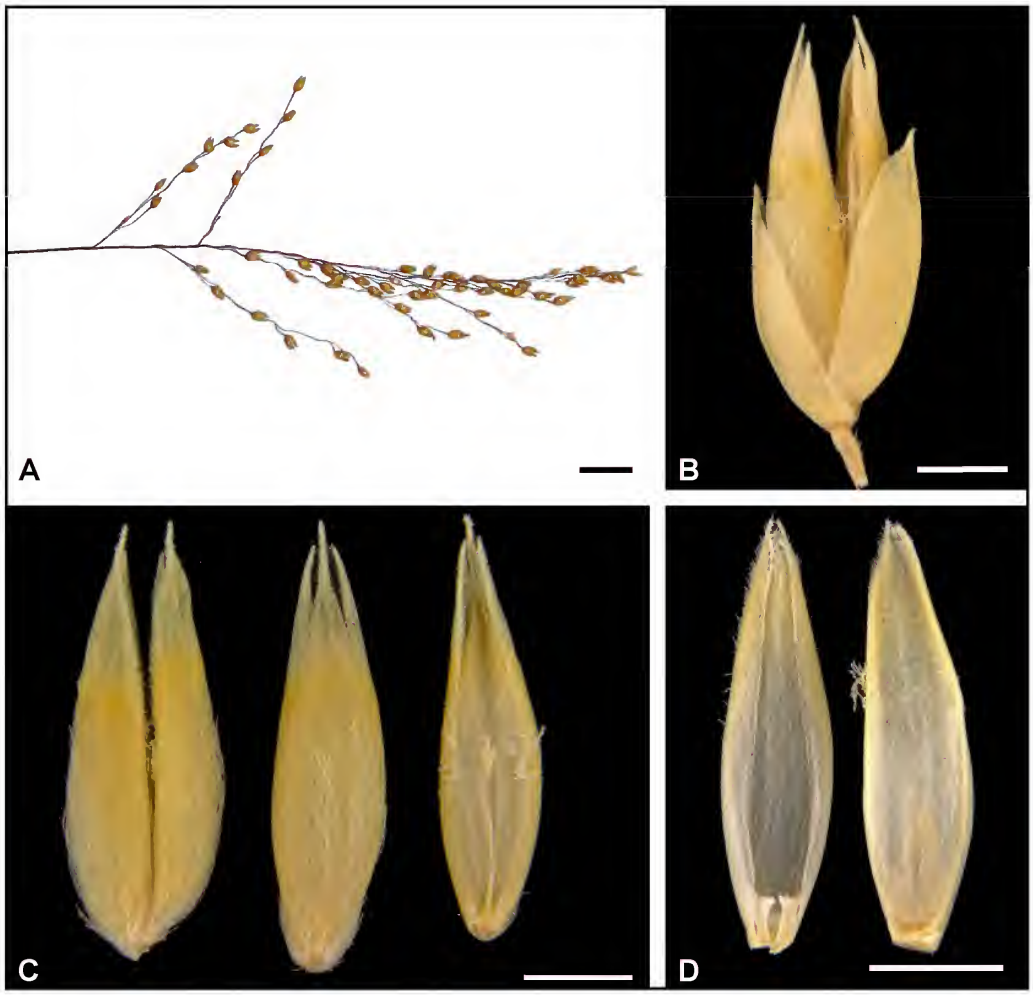

Figure 25. *Triodia diantha*. A – inflorescence; B – spikelet; C – floret (L), outer surface of lemma (Centre) and inner surface of second floret, showing vestigial third floret on a long rachillas (R); D – palea inner (L) and outer (R) surfaces. Scale bars = 1 cm (A); 1 mm (B–D). Images from the holotype *G. Armstrong s.n.* Photographs by M.D. Barrett.

the rachillas). Although *T. diantha* is currently only known from a single collection, the plant condition and uniformity satisfy us that it is a species distinct from all other species of *Triodia*, and not merely an abnormality. The specimen came from a population of uniform-looking plants, and so was not a single aberration (G. Armstrong pers. comm.).

Triodia diantha is superficially similar to *T. pungens* and *T. epactia*, sharing 'soft' type leaf anatomy, resinous foliage, distinctly lobed but non-awned lemmas, and hairy lemma surfaces. It differs in having two fertile florets and a single, long-stalked vestigial floret (*vs* variably 3–9(–17) fertile florets, never having an elongated terminal rachilla internode, and terminal florets not reduced to a minute knob), distinctly elongated, wiry culms (*vs* not obviously elongated), and usually smaller floral dimensions.

Triodia diantha is also similar, especially in habit, to *T. claytonii*, but differs in lacking lemma awns and in having two fertile florets (*vs* one fertile floret), resinous foliage (*vs* usually, but not always, non-resinous), and only a subtle change in lemma texture (*vs* a strong sharp line at the base of the

lemma lobes marking the change of texture). It is superficially similar to *T. cunninghamii*, differing in having less-hairy lemmas, smaller inflorescence and floral dimensions, and two fertile florets and a single, long-stalked vestigial floret (*vs* three florets, the apical-most one smaller but not vestigial). *Triodia diantha* is also superficially similar to *T. stenostachya*, but differs in having subequal lemma lobes (*vs* the lateral lobes distinctly shorter than the central lobe), a narrowly triangular lemma midlobe with an acute apex (*vs* bristle-like) and two fertile florets plus a single, long-stalked vestigial one (*vs* three florets, the apical-most one smaller but not vestigial).

Triodia diantha has a spikelet reminiscent of the Pilbara endemic *T. biflora*, but differs from this species in having hairy lemmas and calli (*vs* glabrous) and distinct lemma lobes (*vs* entire or with minute lobes). *Triodia diantha* differs from *T. celsa* in having resinous foliage (*vs* non-resinous), a hairy callus (*vs* glabrous) and two fertile florets plus a single, long-stalked vestigial one (*vs* 3–5 florets with the apical-most one smaller but not vestigial in *T. celsa*).

The vernacular name Phillips Range Spinifex is suggested.

Violaceae

Hybanthus bennettiae R.L.Barrett, *sp. nov.*

Type: east of Prince Regent Nature Reserve [National Park], Western Australia [precise locality withheld for conservation reasons], 16 January 2010, *R.L. Barrett, M.D. Barrett & M. Maier* RLB 6109 (*holo*: PERTH 08614601; *iso*: CANB, DNA).

Compact *annual* herb, 5–10 cm high, many-stemmed (to 57 stems recorded per plant); *stems* unbranched, finely ribbed, not forming corky bark at base, green to reddish purple, decumbent, with scattered, short, scabrid hairs. *Stipules* linear to narrowly lanceolate, 1.1–2.2 mm long. *Leaves* alternate, widely spaced, sessile or with a petiole to 1.5 mm, narrowly ovate to ovate, sparsely serrate to dentate with 1–6 teeth, or often entire, 6–17 mm long, 1.5–6.0 mm wide, minutely densely papillate, shortly scabrid on margins, dark green. *Flowers* solitary; peduncle 2.5–5.5 mm long; pedicel recurved, 0.4–1.0 mm long, subtended by 2 bracts *c.* 0.6 mm long. *Sepals* narrowly triangular to narrowly ovate, acute, keeled, 1.9–2.6 mm long, with a few scattered hairs along keel and margins otherwise glabrous. *Petals* imbricate, orange; anterior petal spathulate, 5–7 mm long, with a short, blunt spur; 2 outer lateral petals narrowly oblong, *c.* 1.7 mm long; 2 inner lateral petals curved, lanceolate-falcate, 2.0–2.7 mm long. *Stamens* free; filaments dimorphic, ±equal in length, *c.* 0.4 mm long, 2 anterior bearing sessile, sparsely hairy nectaries; *anthers* 0.6–0.8 mm long, oblong-elliptic, with a broad, imbricate, terminal, connective appendage. *Capsule* globular, 3.5–5.0 mm long. *Seeds c.* 6 per capsule, 1.7–1.8 mm long, 0.9–1.0 mm diam., with longitudinal rows of minute pits, yellowish white. (Figure 26)

Diagnostic characters. Distinguished from *H. aurantiacus* (F.Muell. ex Benth.) F.Muell. by the following combination of characters: *annual* herb with decumbent branches; *stipules* short, 1.1–2.2 mm long; *leaves* densely papillate with few marginal teeth or entire; *flowers* small with anterior petal 5–7 mm long; *seeds c.* 6 per capsule, 1.7–1.8 mm long, 0.9–1.0 mm diam., with longitudinal rows of minute pits.

Other specimens examined. Known only from the type collection.

Phenology. Flowering and fruiting recorded in January and March; probably occurring from December to April.

Figure 26. *Hybanthus bennettiae*. A – habitat on thin sheet of sand on sandstone pavement; B – prostrate habit; C – stipules; D – ascending branchlet apex with flower and fruit (below). Images from *R.L. Barrett, M.D. Barrett & M. Maier* RLB 6109 (A, B) and Prince Regent National Park (C, D). Photographs by R.L. Barrett.

Distribution and habitat. Known to occur in the vicinity of Prince Regent National Park in the Kimberley region. Grows on sandstone pavements in herbfields and among sandstone boulders.

Conservation status. *Hybanthus bennettiae* is to be listed as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). It has been observed within Prince Regent National Park and collected just outside its boundary.

Etymology. The epithet acknowledges the work of Eleanor M. Bennett in revising the genus *Hybanthus* Jacq. in Australia (Bennett 1972) and for producing the first guide to the plants of Kings Park (Bennett & Dundas 1988).

Notes. *Hybanthus bennettiae* is most closely related to *H. aurantiacus*, differing in its many-stemmed,

decumbent habit (*vs* 1- or few-stemmed and erect), short stipules (*vs* very long) and densely papillate leaves with few (or no) marginal teeth (*vs* usually glabrous with many marginal teeth). Wahlert *et al.* (2014) recently recommended that the *H. enneaspermus* L. clade, to which *H. bennettiae* belongs, should be recognised as a distinct genus that is yet to be named, so a change in generic name can be anticipated in the near future. A considerable amount of variation was included in a broad concept of *H. aurantiacus* by Bennett (1972) and a detailed revision of this species complex is to be encouraged.

The vernacular name Bennett's Violet is suggested.

Zygophyllaceae

Tribulopis marliesiae R.L.Barrett, *sp. nov.*

Type: [north-east of Broome,] Western Australia [precise locality withheld for conservation reasons], 25 November 2013, *R.L. Barrett & C. Bennison* RLB 8305 (*holo*: PERTH 08614504).

?*Tribulus angustifolius* var. *clementii* Domin, *Biblioth. Bot.* 89: 281 (1926). *Type*: Ashburton and Yule rivers, Western Australia, *s. dat.*, *E. Clement s.n.* (probable *holo*: PR *n.v.*; *iso*: K 725229 image seen).

Slender *herb* with perennial rootstock bearing corky bark, to 40 cm high and 80 cm across. *Stems* erect to spreading at length, 15–45 cm long, sub-glabrous (with just a few minute, scattered, appressed hairs on stems visible at 25×, the hairs more crowded and somewhat erect at base of stem). *Leaves* with (1)2 or 3(4) pairs of leaflets, the lowest pair inserted well-above leaf base; *axis* 26–45 mm long; *leaflets* spreading, filiform to linear, terete to slightly compressed with a subtle groove above when fresh, appearing flat when pressed, 12–36 mm long, 0.4–1.0 mm wide, acute, very sparsely appressed-hairy adaxially and abaxially. *Pedicels* 33–62 mm long and erect in flower, 35–65 mm long and deflexed in fruit. *Sepals* 4.9–6.1 mm long, lanceolate, with scattered appressed hairs to 0.2 mm long adaxially and scattered spreading hairs to 0.5 mm long on margins. *Petals* obovate, obtuse to emarginate, 7.9–11.5 mm long, yellow throughout. *Extrastaminal glands* 5; *intrastaminal glands* lacking. *Stamens* 10, 5 usually shorter, all fertile, at maturity equal to stigma; *filaments* 2.1–3.8 mm long; *anthers* compressed-ovoid, *c.* 0.5 mm long. *Ovary* 5-lobed, with moderately dense to dense, white, appressed hairs. *Style* (including stigma) 3.7–3.9 mm long. *Fruit* appressed-pubescent, comprising usually 5 tardily dissociating, fully developed cocci which are *c.* 7 mm high, smooth, and unarmed. (Figure 27)

Diagnostic characters. Distinguished from *T. angustifolia* R.Br. by the following combination of characters: erect *perennial* herb with branches decumbent at length; *stem* with corky bark at base when old; *indumentum* very sparse, appressed; *leaves* usually with 2 or 3 pairs of filiform, linear leaflets that are subtly grooved above; *flowering pedicels* 33–62 mm long.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 27 Nov. 2013, *R.L. Barrett & C. Bennison* RLB 8325 (PERTH); 28 Nov. 2013, *R.L. Barrett & C. Bennison* RLB 8338 (PERTH); 14 Nov. 1999, *Duero [D. Dureau], [T.] Handasyde, McCartney & [T.] Willing* WESD2-37a (PERTH); 14 Nov. 1999, *Duero [D. Dureau], [T.] Handasyde, McCartney & [T.] Willing* WESD2-37b (PERTH); 1 Oct. 2004, *G. Byrne* 1279 (PERTH); 24 Aug. 2001, *C.P. Campbell* 3563 (PERTH).

Phenology. Flowering and fruiting recorded from August to November.

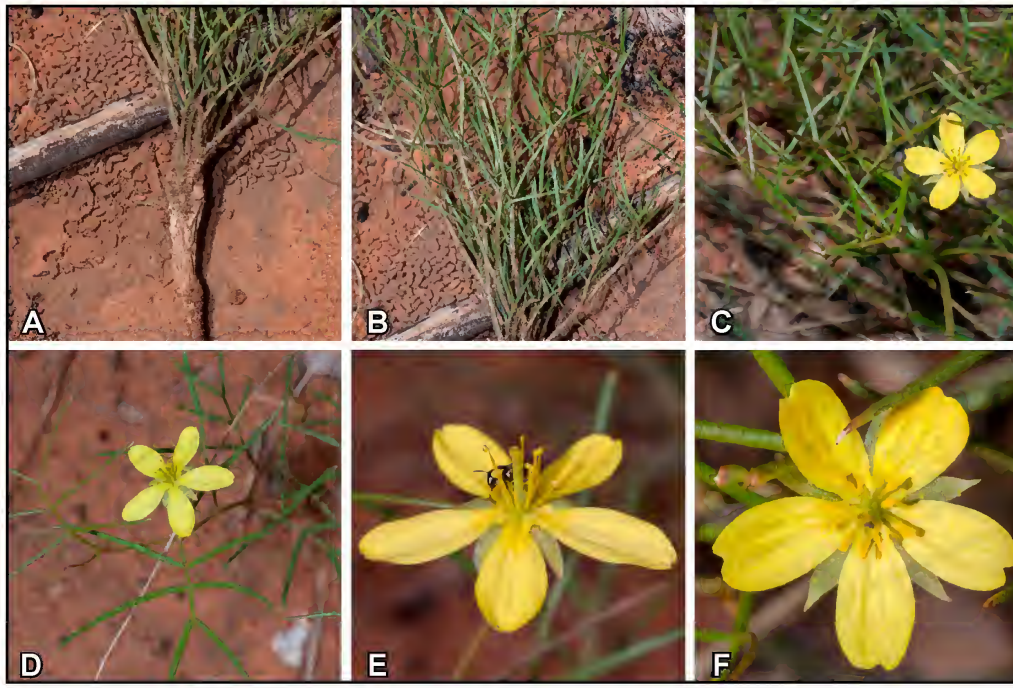

Figure 27. *Tribulopis marliesiae*. A – corky, perennial stem base; B – erect branchlets with pinnate leaves; C, D – flowering branchlet with filiform leaflets; E – lateral view of flower; F – top view of flower. Images from *R.L. Barrett & C. Bennison* RLB 8305. Photographs by R.L. Barrett.

Distribution and habitat. Occurs from Pardoo Roadhouse north to Roebuck Plains Station in the Dampier Botanical District and inland to the northern Great Sandy Desert. Restricted to red sands in heath and low pindan, particularly with *Acacia tumida*. This species often co-occurs with *Tribulopis angustifolia* R.Br.

Conservation status. *Tribulopis marliesiae* is to be listed as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). It is known only from five widely disjunct locations, but probably occurs in intervening locations as well.

Etymology. The epithet honours the late Marie-Luise (Marlies) Eichler (dec. 2010), for her support of her husband Hansjörg Eichler (1916–1992) who studied Zygophyllaceae (Eichler 1981, 1984; Barker 1996, 2013) and her generous support of the Australasian Systematic Botany Society.

Notes. The few collections made of this species were either not identified to species, or had been assigned to *T. angustifolia*. Field observations of *T. marliesiae* by one of us (RLB) found that it grew intermixed with *T. angustifolia* but with no morphological intermediates. *Tribulopis angustifolia* differs in being a prostrate or decumbent annual (*vs* erect perennial with a corky barked stem) with flat leaflets (05–)0.8–1.5(–3.5) mm wide (*vs* terete to compressed, 0.4–1.0 mm wide).

As a perennial, *T. marliesiae* has the ability to flower quickly following rain, allowing collection of fertile material at the onset of the wet season. Flowering probably continues through the wet season when access to habitats is more difficult.

The type of *Tribulus angustifolius* var. *clementii* Domin appears to match this taxon, but only an image of the sheet at Kew has been examined and no modern collections are known from the Yule or Ashburton Rivers; further studies are recommended.

The vernacular name Eichler's Tribulopis is suggested.

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Four new species of *Boronia* (Rutaceae) from the Kimberley region of Western Australia

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Abstract

Barrett, R.L., Barrett, M.D. & Duretto, M.F. Four new species of *Boronia* (Rutaceae) from the Kimberley region of Western Australia. *Nuytsia* 26: 89–109 (2015). Four new species of *Boronia* Sm. are described from the North Kimberley region of Western Australia: *B. cremnophila* R.L.Barrett, M.D.Barrett & Duretto, *B. interrex* R.L.Barrett, M.D.Barrett & Duretto, *B. marcoana* R.L.Barrett & M.D.Barrett and *B. thedae* R.L.Barrett, M.D.Barrett & Duretto. All of these species have very restricted distributions and are of conservation concern. All new species are illustrated. A revised key to *Boronia* species in the Kimberley region is provided.

Introduction

The Kimberley region is a minor centre of diversity for the genus *Boronia* Sm. with nine species recognised in the region by Duretto *et al.* (2013). With the addition of the four species named here, nine species are considered to be endemic to the Kimberley, with four species shared with the Northern Territory, and one of these extending to Queensland. Endemic species include the unusual *B. anomala* Duretto, still only known from the type collection (Duretto 1999). Duretto (2006) indicated that further studies should be undertaken on poorly known species, particularly in the *B. pauciflora* W.Fitzg. species complex. Most Kimberley species occur on rough, broken sandstone, though the widespread species *B. wilsonii* (F.Muell. ex Benth.) Duretto also occurs in open woodland on sandstone and laterite. In the Northern Territory, a number of species are known from cliff faces, and significant time has been spent searching similar habitats in the Kimberley region. A cliff-dwelling species was finally located in the Kimberley region in 2010, named here as *B. cremnophila* R.L.Barrett, M.D.Barrett & Duretto.

As a genus with many highly localised species, details of micromorphology are critical to the accurate recognition of taxa. Duretto (1997, 1999) has provided a detailed discussion of the key characteristics for defining taxa in *Boronia* ser. *Lanuginosae* Duretto and included numerous Scanning Electron Microscope (SEM) images to aid character recognition and interpretation. We have undertaken similar imaging work for each of the species described here. While Duretto (1997, 1999) did not assess pollen morphology, there are some apparent differences between species in the *B. kalumburuensis* Duretto

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species group. *Boronia interrex* R.L.Barrett, M.D.Barrett & Duretto shows particular differences to its putative closest relatives (*B. kalumburuensis*, *B. marcoana* R.L.Barrett & M.D.Barrett and *B. thedae* R.L.Barrett, M.D.Barrett & Duretto; Figure 5). Pollen of *B. interrex* is sub-globular and consistently has a raised dome in the centre of each colpus. Smaller domes may occasionally be present in the other species in this complex. The remaining species have pollen that is typical of many Australian Rutaceae. Further studies of pollen morphology in *Boronia* may identify characters that are useful for infrageneric classification.

Boronia kalumburuensis was recognised by Duretto (1997) based on a small number of collections from around Kalumburu and Theda Station. It is placed in *Boronia* subser. *Filicifoliae* Duretto (ser. *Lanuginosae*) which currently contains four other described species, *viz. B. barrettiorum* Duretto, *B. filicifolia* A.Cunn. ex Benth., *B. minutipinna* Duretto and *B. pauciflora* (Duretto 1999; Duretto *et al.* 2013). Other Kimberley species from ser. *Lanuginosae* are *B. jucunda* Duretto (subser. *Jucundae* Duretto), *B. lanuginosa* Endl. and *B. wilsonii* (subser. *Lanuginosae*). Further fieldwork in the region has provided additional collections of *B. kalumburuensis s. lat.* from known locations, as well as new populations from the King Edward River to Lawley River and Prince Regent River. These additional populations each have their own unique characteristics, requiring a reassessment of species boundaries in *B. kalumburuensis* and *B. wilsonii*. Careful study of these populations has concluded that three taxa should be recognised at species rank from *B. kalumburuensis s. lat.* and we describe *B. interrex* R.L.Barrett, M.D.Barrett & Duretto, *B. marcoana* R.L.Barrett & M.D.Barrett and *B. thedae* R.L.Barrett, M.D.Barrett & Duretto as new. These three species all have mottled seeds and are placed in *Boronia* subser. *Filicifoliae*. Further field study of *B. wilsonii* has shown that populations in the Drysdale River area are unusual and may require taxonomic recognition in the future. The new species described here may blur the division between subser. *Lanuginosae* and subser. *Filicifoliae*.

Another new species related to *B. pauciflora* and *B. barrettiorum* has been discovered on sandstone cliffs to the north-west of Mount Elizabeth Station and this is described here as *B. cremnophila* R.L.Barrett, M.D.Barrett & Duretto. Detailed studies of *B. pauciflora* are still required to determine the appropriate rank for geographic variants currently included in that species (see also discussion in Duretto 2006).

Methods

All measurements are based on dried herbarium material. All taxa newly described here have been examined in the field by the first two authors of this paper and colour descriptions are based on observations of fresh specimens or from photographs taken in the field. Descriptions are based on the format of Duretto (1997). Features of micromorphology, including indumentum and seed surface patterns, are particularly important in *Boronia* taxonomy and detailed illustrations are provided for comparative purposes. Dry leaves, stems and seeds were mounted on stubs using double-sided carbon tape with conductive carbon paint, coated with gold using an EMITECH K550X Sputter Coater and imaged at high vacuum and high voltage (15 KVa) using a Jeol JCM 6000 NeoScope bench-top SEM at Kings Park and Botanic Garden.

Key to *Boronia* species in the Kimberley region of Western Australia

This key has been revised from Duretto (2006) to include the new species described here.

1. Plants glabrous (apart from petals and stamens); leaves 3–5-foliolate; leaflets linear, <1 mm wide; sepals *c.* 1.25 mm long, < 1/2 the length of the petals ..... **B. anomala**

1: Plants glabrescent or with a sparse to dense indumentum; leaves 1–55-foliolate;

leaflet shape various, mostly >1 mm wide; sepals 3.5–15 mm long, usually >1/2 length of petals **2**

2. Leaves simple or ternate (rachis absent) **3**

2: Leaves 5–55-pinnate (rachis present) **6**

3. Leaflets linear; younger branches glandular tuberculate (also NT) ..... **B. jucunda**

3: Leaves or leaflets lanceolate to ovate to elliptic; branches not obviously glandular **4**

4. Plant cliff-dwelling, base of stem thick and corky; terminal leaflets 6–18 mm long, 1.5–3 mm wide ..... **B. cremnophila**

4: Plant on broken sandstone, base of stem slender, lacking any corky bark; terminal leaflets 10–80 mm long, 2–12 mm wide **5**

5. Leaves glabrescent, 12–80 mm long ..... **B. pauciflora**

5: Leaves with a moderately dense indumentum (sometimes not clearly visible to the naked eye, though particularly noticeable on new foliage, at least on dry specimens, making them appear white), 8–30 mm long ..... **B. barrettiorum**

6. Leaves with a moderately dense (epidermis visible) to dense (epidermis not visible) stellate indumentum; sepals (4–)5–15 mm long, larger than petals, abaxial surface with a dense indumentum; petals 3–10 mm long; anthopodium (pedicel) 3–6(–10) mm long **7**

6: Leaves glabrescent or with a sparse to moderately dense stellate indumentum; sepals 3.5–6 mm long, smaller to larger than petals, abaxial surface glabrous, glabrescent or with a sparse indumentum; petals 2.5–4.5 mm long; anthopodium 1–24 mm long **8**

7. Leaflets linear to narrowly elliptic, so revolute that abaxial surface not usually visible; sepals 5–14 mm long (E of Ord R.; also NT & Qld) ..... **B. lanuginosa**

7: Leaflets elliptic to lanceolate, abaxial surface visible; sepals 5–9 mm long (W of Ord R.; also NT) ..... **B. wilsonii**

8. Terminal leaflets 1–2 mm long, lateral leaflets 0.5–1.5 mm long; anthopodium 1–6 mm long ..... **B. minutipinna**

8: Terminal leaflets (1.5–)3–11 mm long, lateral leaflets 0.5–8 mm long; anthopodium (2–)6–21 mm long **9**

9. At least some leaves with >30 leaflets present, (7–)30–75 mm long; leaflets elliptic to rhombic to circular; petiole 0–2 mm long; sepals 2–3.5 mm long, shorter to longer than petals (also NT) ..... **B. filicifolia**

9: Leaves with <30 leaflets (if >30 leaflets then some petioles >3 mm long), 8–40(–56) mm long; leaflets linear to elliptic; petiole 0.2–7 mm long; sepals 3.5–6 mm long, as long or longer than petals **10**

10. Petiole 2.8–6.9 mm long; rachis segments widest across the middle; anthopodium with a dense stellate indumentum; petals slender, 0.7–0.8 mm wide ..... **B. interrex**

10: Petiole 0.2–1.0 mm long; rachis segments widest at distal end; anthopodium with a sparse to moderately dense stellate indumentum; petals broad, 1.0–1.5 mm wide **11**

11. Mature plants erect to spreading, leaves and younger stems remaining green; stem indumentum of short stellate hairs to 0.5 mm long and long simple hairs to 1.8 mm long; petals 1/2 to 2/3 as long as sepals ..... **B. marcoana**

11: Mature plants erect at first, then spreading or quickly becoming decumbent, leaves and younger stems turning reddish in sun; stem indumentum of mixed short

stellate hairs to 0.25 mm long and long simple hairs 0.6–0.9 mm long or short to long stellate hairs 0.1–0.7 mm long; petals 2/3 to as long as sepals..... **12**

12. Mature plants semi-erect to spreading; indumentum of moderately dense, fine to robust, mixed short to long stellate hairs 0.1–0.7 mm long on stems (long simple hairs apparently absent); cocci occasionally glabrous but usually with evenly scattered, very short stellate hairs..... **B. kalumburuensis**

12: Mature plants quickly becoming decumbent; indumentum of sparse to moderately dense, fine, mixed short stellate hairs up to 0.25 mm long and long simple hairs 0.6–0.9 mm long on stems; cocci occasionally glabrous but usually with scattered, short stellate hairs, denser towards the margins..... **B. thedae**

Taxonomy

Boronia cremnophila R.L.Barrett, M.D.Barrett & Duretto, *sp. nov.*

Type: [north-west of Mount Elizabeth Station homestead,] Western Australia [precise locality withheld for conservation reasons], 28 March 2010, *R.L. Barrett & M.D. Barrett* RLB 6770 (*holo*: PERTH 08614644; *iso*: BM, BRI, CANB, CNS, DNA, K, MEL, NSW).

Erect or spreading, open *shrub* to 80 cm high and 1 m wide, occasionally some *branches* pendulous on large shrubs, mature growth dark green; usually glabrous throughout, apart from flowers. Multiangular stellate *hairs* found rarely on very new growth in the interpetiolar region and on the pedicels, when present hairs few, small, sessile, with up to 8 (occasionally more) rays; rays unicellular, unfused, firm, straight, not appressed, glossy, smooth, white, to 0.2 mm long. *Branches* ±terete, decurrent leaf bases absent, not glandular, glabrous, base of primary stem with 2–8 cm of distinctly fissured, somewhat corky bark. *Leaves* opposite-decussate, 1- or 3-foliolate, usually both types present on a given branch, mostly 3-foliolate, 7–20 mm long, 7–15 mm wide; lamina slightly discolorous, paler beneath, weakly dorsiventral, obviously glandular; margins entire, flat to slightly revolute; midrib not impressed adaxially, raised abaxially; pinnae with petiolules to 2.7 mm long, lanceolate to narrowly elliptic, tip acute, attenuate; unifoliolate and terminal pinnae longer than laterals, 6–18 mm long, 1.5–3 mm wide, midvein straight; lateral pinnae opposite, 4–9 mm long, 1.1–2.6 mm wide; petioles not winged. *Inflorescence* cymose, 1(2)-flowered; peduncle *c.* 1 mm long; prophylls minute; metaxyphylls absent or possibly minute; anthopodium (pedicel) ±glabrous (rarely a few stellate hairs present), 3.3–4.8 mm long. *Sepals* distinctly larger than petals, white with pale green apices, narrowly triangular to narrowly-deltate, acute, 3.5–4.4 mm long, 1.2–1.3 mm wide, not obviously enlarging with fruit; adaxial surface with a moderately dense to dense stellate indumentum, becoming glabrous towards base; abaxial surface glabrous except margins. *Petals* white, grading to pale pink at the base, 3.0–3.3 mm long, 0.7–0.9 mm wide, not elongating significantly with mature fruit; adaxial surface with a dense stellate indumentum, becoming glabrous towards base; abaxial surface with a moderately dense stellate indumentum, particularly at the apex and margins. *Stamens* with filaments bearing stiff simple and bifid hairs abaxially and on margins below glandular tip; antesepalous filaments clavate, prominently glandular, suddenly narrowing to anther connective, 0.9–1.1 mm long; antepetalous filaments prominently glandular, warty, 1.4–1.6 mm long; anthers with abaxial surface not frosty, antepetalous ones much larger than antesepalous; anthers shortly apiculate, glabrous; pollen not examined. *Ovary* glabrous; style pilose; stigma rounded, not or scarcely wider than style. *Cocci* glabrous, 4.9–5.5 mm long, 2.0–2.7 mm wide. *Seeds* with a prominent ridge on adaxial side, shiny, pale brown to grey when young, black but mottled when mature, 3.5–3.8 mm long, 1.5–1.7 mm wide; surface at magnification irregular, sub-tuberculate; tubercules smooth, unfused, anticlinal walls ±visible, 20–40 µm across; elaiosome white, to 1.9 mm long. (Figures 1, 2)

Figure 1. *Boronia cremnophila*. A – habitat on sparsely vegetated sandstone cliffs, B – habit of plants growing in fissures on cliff faces, C – corky bark at base of stem and orange stem below bark, D – flowering branchlet, E – paired flowers from above, F – close-up of petals and stamens showing detail of indumentum. Images from *R.L. Barrett & M.D. Barrett* RLB 6770. Photographs by R.L. Barrett.

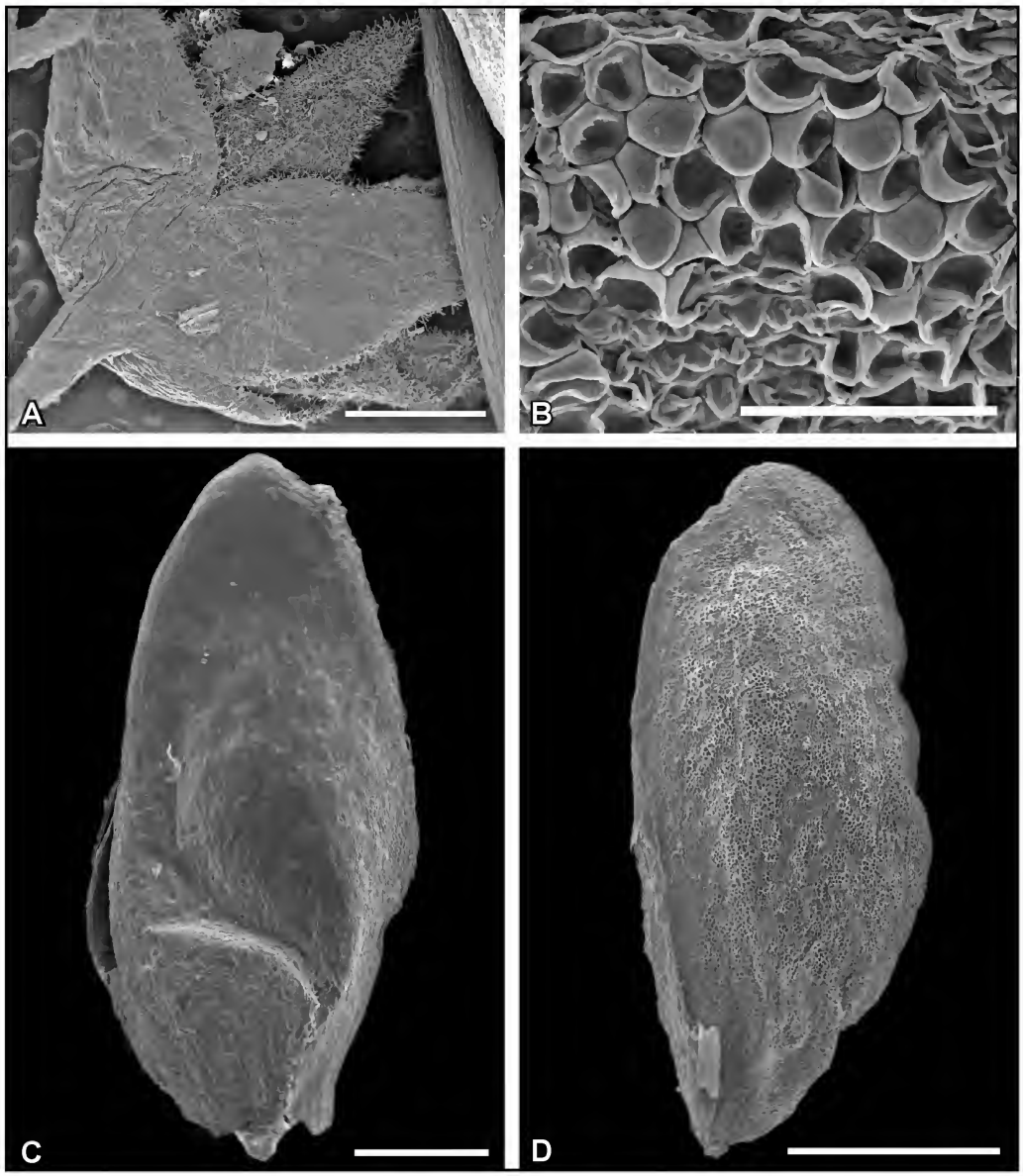

Figure 2. SEM images of *Boronia cremnophila*. A – flower showing abaxial surface of sepals and petals; B – immature seed surface from centre of seed; C – single coccus (lateral view); D – immature seed with elaiosome removed (lateral view). Scale bars = 1 mm (A, C); 100 µm (B); 500 µm (D). Images from *R.L. Barrett & M.D. Barrett* RLB 6770. Images by R.L. Barrett.

Diagnostic characters. Distinctive in its cliff-dwelling *habitat*. *Stems* glabrous. *Bark* corky at the base of the stem. *Leaves* 1- or 3-foliolate, glabrous, terminal pinnae small, 6–18 mm long, 1.5–3 mm wide.

Other specimens examined. Only known from the type collection.

Phenology. Flowering and fruiting recorded for March, but probably from January to May.

Distribution and habitat. Only known from a small number of locations north-west of Mount Elizabeth Station homestead in the north-west Kimberley where it grows on small, vertical, sandstone cliff faces. Plants grow in vertical rock fissures with *Ficus* and *Triodia*.

Conservation status. *Boronia cremnophila* is to be listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). Four populations are known over a range of about 5 km, with a total of around 500 plants known. Only one population was accessible on the ground, the other three populations being identified and surveyed from a helicopter. There are only a limited number of cliffs in the vicinity of the known locations and this species is likely to be highly localised and rare.

Etymology. The epithet is from the Latin *cremnos* (cliff) and *-philus* (loving), in reference to the cliff-dwelling habitat of this species.

Notes. *Boronia cremnophila* is most closely related to *B. barrettiorum* and *B. pauciflora* which are also endemic to the western Kimberley region (Duretto 1997, 2006). *Boronia cremnophila* is readily distinguished from *B. pauciflora s. lat.* by its cliff-dwelling habitat, corky bark at the base of the stem and small terminal leaflets, 6–18 mm long, 1.5–3 mm wide.

There are a number of cliff-specialising *Boronia* species in the Northern Territory along the Kakadu escarpment. Two, *B. viridiflora* Duretto and *B. suberosa* Duretto, are in the same subsection (*Grandisepalae*) as *B. cremnophila* but in different series, while *B. rupicola* Duretto is in its own series of subsect. *Valvatae* (see Duretto & Ladiges 1997; Duretto 1997, 1999; Duretto *et al.* 2013). *Boronia cremnophila* and *B. suberosa* are the only species in *Boronia* that have massive cork development. They are also the two cliff specialists that are semi-erect to erect; *B. rupicola* is pendulous and *B. viridiflora* grows perpendicular to the cliff face. It would appear that cliff specialisation has independently evolved four times in *Boronia*, and massive cork development twice, all in the north-west of Australia, on sandstone plateaux in relatively high rainfall zones.

This species was discovered by R.L. and M.D. Barrett on a targeted collecting trip funded by the Botanic Gardens and Parks Authority in March 2010.

The vernacular name of Kimberley Cliff Boronia is suggested.

Boronia interrex R.L.Barrett, M.D.Barrett & Duretto, *sp. nov.*

Type: Prince Regent Nature Reserve [National Park] [precise locality withheld for conservation reasons], Western Australia, 16 January 2010, *R.L. Barrett, M.D. Barrett & M. Maier* RLB 6110 (*holo*: PERTH 08614679; *iso*: BM, BRI, CANB, CNS, DNA, K, MEL, NSW, PERTH 08642745).

Spreading to erect or decumbent, much branched *shrub* to 80 cm high and 150 cm across, branches sometimes supported by surrounding vegetation, mature growth becoming red-green to purple-red in appearance in sun-exposed positions; *indumentum* of both stellate and simple hairs, moderately dense on young growth, but becoming sparse when mature. Multiangular *stellate hairs* sessile, with 5–8 rays; rays unicellular, unfused, firm, straight, not appressed, glossy, smooth, white, 0.2–0.4 mm long. *Simple hairs* erect, 1–1.3 mm long. *Branches* terete, decurrencies absent, not obviously glandular, hair distribution even, becoming glabrous with age, little or no cork development. *Leaves* opposite-decussate, imparipinnate, (3–)5–11(–13) pinnae, not becoming unifoliolate with age, 10–37 mm long, 8–16 mm wide; lamina discolorous, paler beneath, dorsiventral, indumentum moderately dense (slightly denser

beneath), not obviously glandular; margins entire, usually planar, occasionally recurved; midribs of leaflets and rachis segments slightly impressed adaxially, prominently raised abaxially; pinnae sessile to very shortly petiolate with petiolule up to 0.6 mm long, elliptic to ovate, tip obtuse; terminal pinnae 6.4–11.5 mm long, 3.3–4.7 mm wide, longer than laterals, midvein straight; lateral pinnae opposite or rarely subopposite, 3.5–7.8 mm long, 2.0–3.6 mm wide; rachis segments winged, oblanceolate to narrowly rhombic, middle widest, 2.2–5.3 mm long, 0.8–1.6 mm wide; petiole not winged, 2.8–6.9 mm long; some juvenile leaves persisting, larger than mature leaves, indumentum similar. *Inflorescence* cymose, 1-flowered; peduncle to 5.5 mm long; prophylls to 0.9 mm long, persistent; metaxyphylls absent or minute and persistent; anthopodium with a dense stellate indumentum, 7.5–15.0 mm long. *Sepals* longer and wider than petals, cream to pale pink, narrowly ovate-deltoid, acuminate, 3.6–5.6 mm long, 1.1–1.4 mm wide, enlarging to 5.9 mm long and 2.3 mm wide with fruit; adaxial surface with a dense stellate and simple indumentum near margins becoming a moderately dense simple indumentum towards centre and base; abaxial surface with a sparse stellate indumentum. *Petals* pale pink, darker at the base, 2.6–3.7 mm long, 0.7–0.8 mm wide, elongating to 4.2 mm long with mature fruit, abaxial midrib not or slightly raised at base; adaxial surface with a dense simple and few-branched stellate indumentum, becoming a moderately dense simple indumentum towards centre and very dense towards base; abaxial surface with a dense simple and few-branched stellate indumentum. *Stamens* with filaments bearing stiff simple hairs abaxially and on margins; antesepalous filaments clavate, suddenly narrowing to anther connective, 1.2–1.4 mm long, distal 0.6–0.7 mm prominently glandular; antepetalous filaments warty, 0.9–1.0 mm long; anthers with abaxial surface not frosty, antepetalous ones much larger than antesepalous; anther apiculum minute, glabrous; pollen sub-globular, *c.* 20 µm long, with a raised dome in the centre of each colpus. *Ovary* glabrous; style glabrous; stigma rounded, not or scarcely wider than style. *Cocci* with a sparse simple and stellate indumentum, 3.2–5.4 mm long, 2.0–2.9 mm wide. *Seeds* with prominent ridge on adaxial side, shiny, black and mottled brown, 3.7–3.9 mm long, 1.8–2.1 mm wide, surface at magnification tuberculate to colliculate; tubercles and collicles smooth, unfused, anticlinal walls ±visible, 15–40 µm across; elaiosome yellow-white, to 2.3 mm long. (Figures 3; 4A, B; 5A; 6A; 7A, B; 8A, B; 9A)

Diagnostic characters. Spreading to erect or decumbent *shrub*, mature growth becoming red-green to purple-red in appearance. *Indumentum* sparse on mature plants; stellate hairs 0.2–0.4 mm long. *Leaves* with (3–)5–11(–13) pinnae; pinnae elliptic to ovate, tip obtuse. *Anthopodium* 7.5–15.0 mm long, with a dense stellate indumentum. *Petals* 2.6–3.7 mm long in flower, 0.7–0.8 mm wide, adaxial surface with a dense simple and few-branched stellate indumentum, becoming a moderately dense simple indumentum towards centre and very dense towards base; abaxial surface with a dense simple and few-branched stellate indumentum. *Cocci* with a sparse stellate indumentum, 3.2–5.4 mm long, 2.0–2.9 mm wide.

Other specimen examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 10 Jan. 2001, *R.L. Barrett & M.D. Barrett* RLB 1663 (PERTH).

Phenology. Flowering and fruiting collections made in January.

Distribution and habitat. Known only from the summit of a single sandstone mesa just outside Prince Regent National Park. Small step-sandstone pavement with skeletal sands. Grows with low shrubs, including *Acacia adenogonia*, *A. latifolia*, *A. retinervis*, *Grevillea latifolia*, *Jacksonia rupestris* and *Triodia* sp., and scattered *Eucalyptus* ?*herbertiana* on pavement margins.

Conservation status. *Boronia interrex* is to be listed as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.).

Figure 3. *Boronia interrex*. A – sprawling habit on sandstone, B – flowering branchlet, C – petiolate mature leaf, showing rachis segments widest across the middle; D – flowering branchlet from shaded habitat; E – lateral view of inflorescence in leaf axils; F – close-up of petals and stamens. Images from *R.L. Barrett, M.D. Barrett & M. Maier* RLB 6110. Photographs by R.L. Barrett.

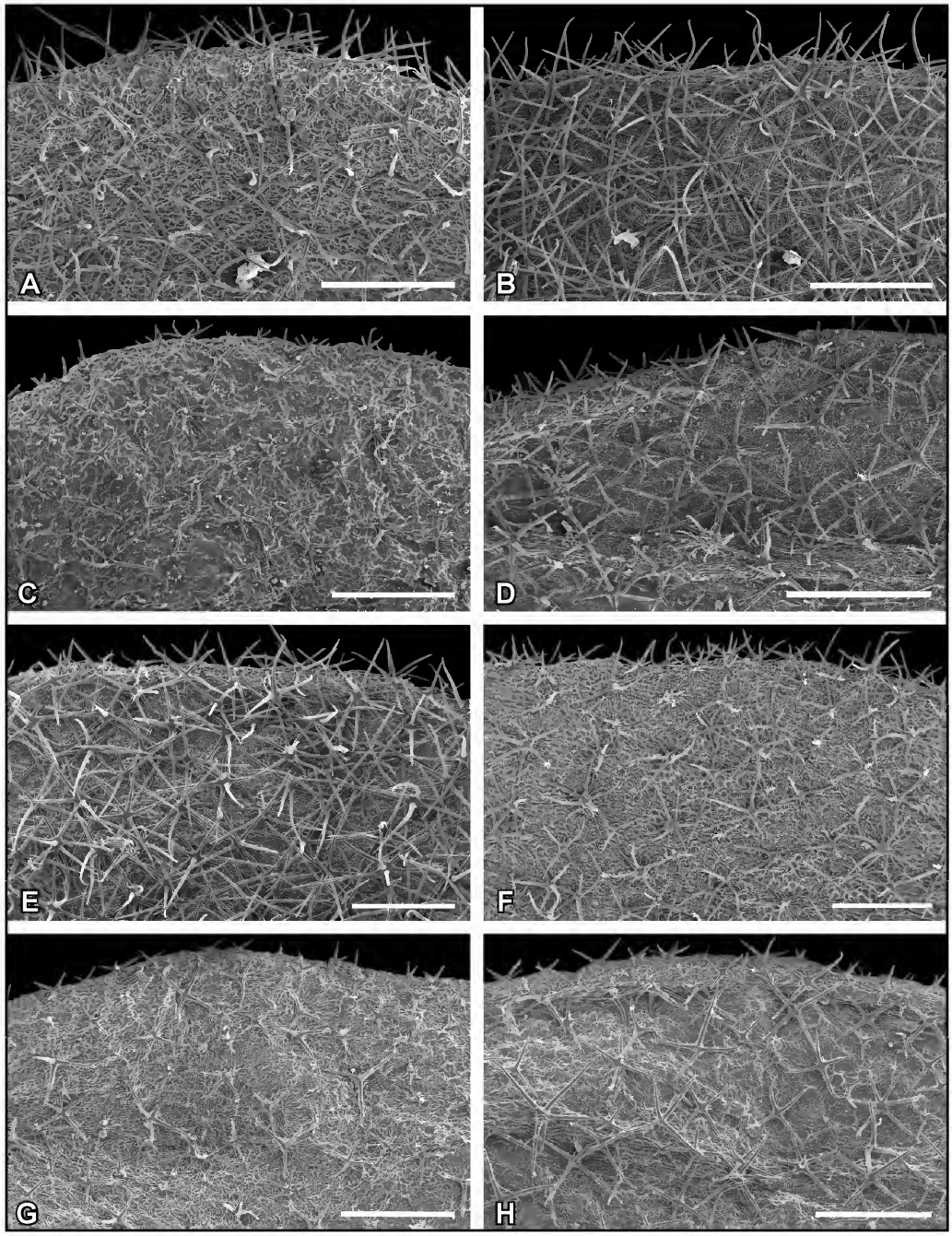

Figure 4. SEM images of mature leaves showing adaxial surface (A, C, E, G) and abaxial surface (B, D, F, H). A, B – *Boronia interrex* (indumentum moderately dense); C, D – *B. kalumburuensis* (indumentum sparse above, moderately dense below); E, F – *B. marcoana* (indumentum moderately dense above, sparse below); G, H – *B. thedae* (indumentum sparse). Scale bars = 500 μm. Images from *R.L. Barrett & M.D. Barrett* RLB 1663 (A, B), *M.D. Barrett & R.L. Barrett* MDB 3119 (C, D), *R.L. Barrett & M.D. Barrett* RLB 6830 (E, F) and *R.L. Barrett* RLB 8868 (G, H). Images by R.L. Barrett.

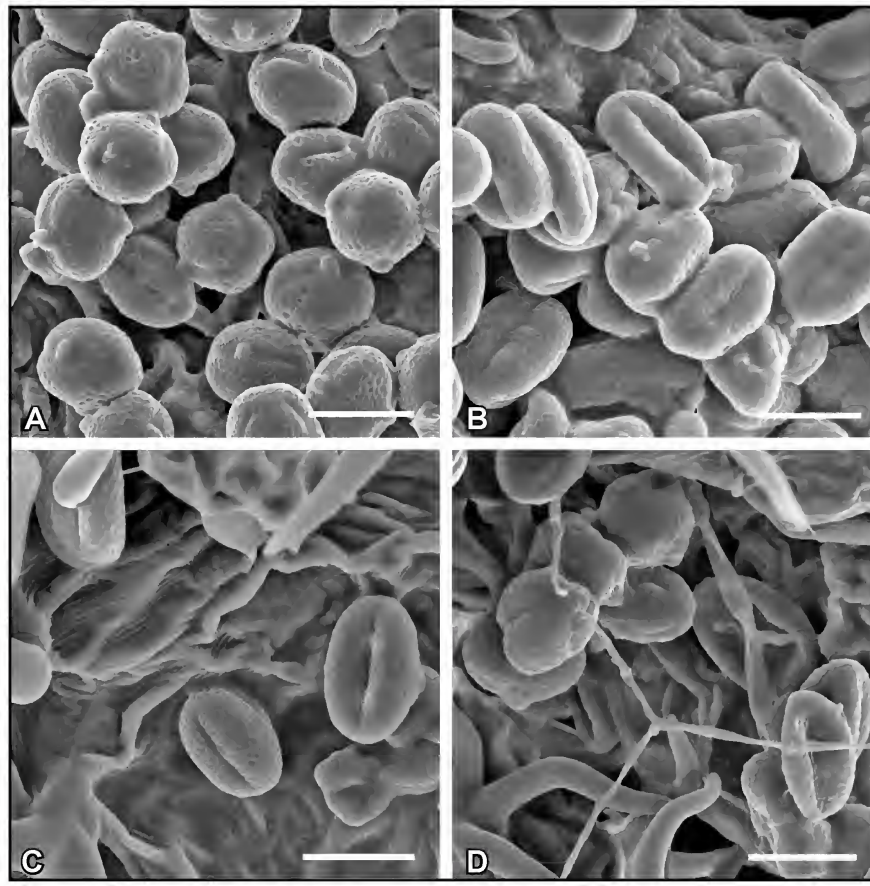

Figure 5. SEM images of pollen. A – *Boronia interrex* (note raised dome in the centre of each colpus); B – *B. kalumburuensis*; C – *B. marcoana*; D – *B. thedae*. Scale bars = 20 μm. Images from *R.L. Barrett & M.D. Barrett* RLB 1663 (A), *M.D. Barrett & R.L. Barrett* MDB 3119 (B), *R.L. Barrett & M.D. Barrett* RLB 6830 (C) and *R.L. Barrett* RLB 8868 (D). Images by R.L. Barrett.

Etymology. The epithet is from the Latin *interrex* (a regent, temporary king), in reference to the location of this species in Prince Regent National Park.

Notes. *Boronia interrex* is superficially similar to *B. wilsonii* which occurs nearby, but differs in the fewer, broader leaflets, sparse indumentum and longer anthopodium, features which clearly relate it to *B. kalumburuensis*. It can be readily distinguished from *B. kalumburuensis* by the long petioles 2.8–6.9 mm long (similar to *B. wilsonii*), the rachis segments being widest in the middle, the anthopodium with a dense stellate indumentum and the slender petals 0.7–0.8 mm wide.

Discovered in 2001 by R.L. and M.D. Barrett, this collection was noted to differ from *B. wilsonii*, but was not immediately associated with *B. kalumburuensis*, and with only a single known collection was not described at the time. A second population was found nearby in 2010, verifying the consistency of this taxon and allowing its real relationships to be determined.

The vernacular name of Prince Regent River Boronia is suggested.

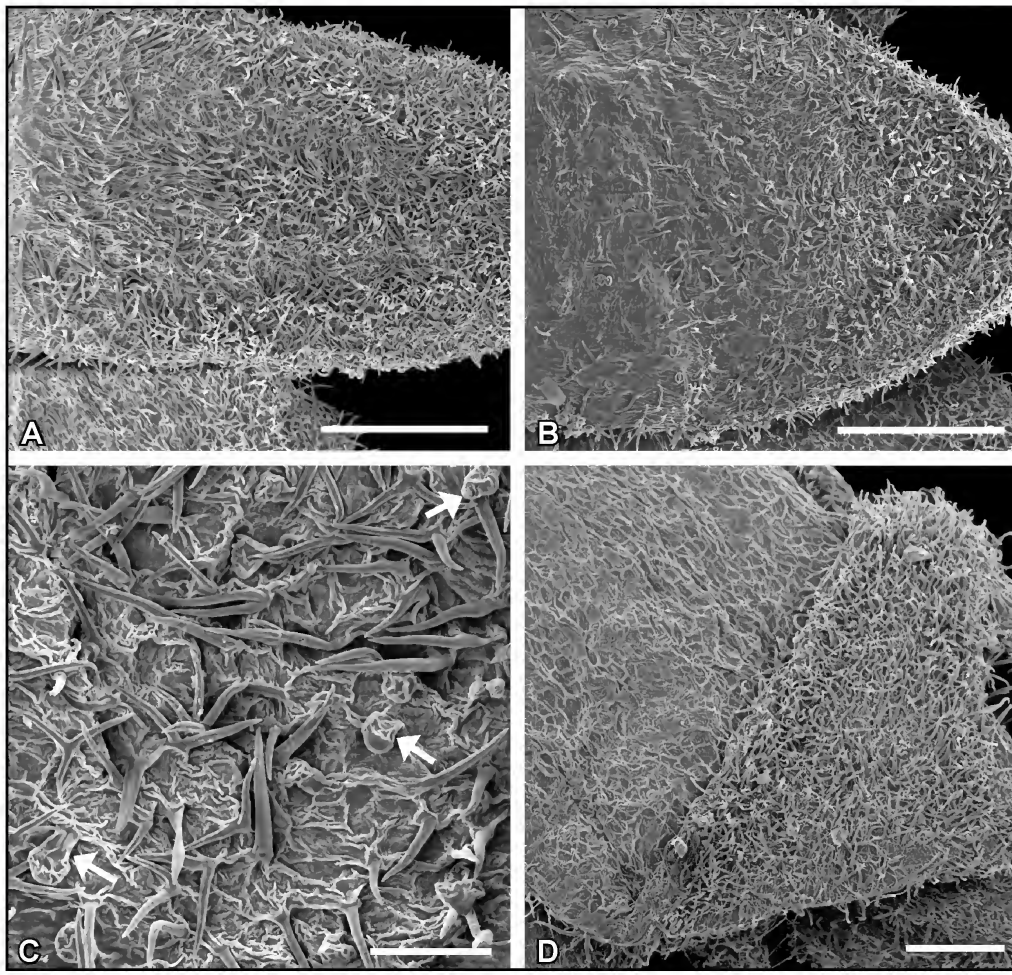

Figure 6. SEM images of petal indumentum on adaxial surface. A – *Boronia interrex* (dense stellate and simple indumentum near margins, becoming a moderately dense simple indumentum towards centre and base; few stalked glands also visible); B – *B. kalumburuensis* (moderately dense stellate and simple indumentum near margins, becoming a sparse simple indumentum towards centre and base); C – *B. marcoana*, (showing unusual stalked glands (arrowed) at higher magnification); D – *B. thedae* (moderately dense to dense simple and stellate indumentum as well as scattered, stalked glandular hairs, extending to the base). Scale bars = 500 μm (A, B, D); 100 μm (C). Images from *R.L. Barrett & M.D. Barrett* RLB 1663 (A), *M.D. Barrett & R.L. Barrett* MDB 3119 (B), *R.L. Barrett & M.D. Barrett* RLB 6830 (C) and *R.L. Barrett* RLB 8868 (D). Images by R.L. Barrett.

Boronia marcoana R.L.Barrett & M.D.Barrett, *sp. nov.*

Type: near Lawley River [precise locality withheld for conservation reasons], Western Australia, 29 March 2010, *R.L. Barrett & M.D. Barrett* RLB 6830 (*holo*: PERTH 08614725; *iso*: BM, BRI, CANB, CNS, DNA, HO, K, MEL, NSW).

Illustration. A.J.G. Wilson (ed.) *Fl. Austral.* 26: pl. 34 (2013), as *B. kalumburuensis*.

Erect to spreading, few- or many-branched *shrub* to 100 cm high and 120 cm wide, leaves and younger stems remaining pale to dark green in sun-exposed positions; with a sparse to moderately dense stellate

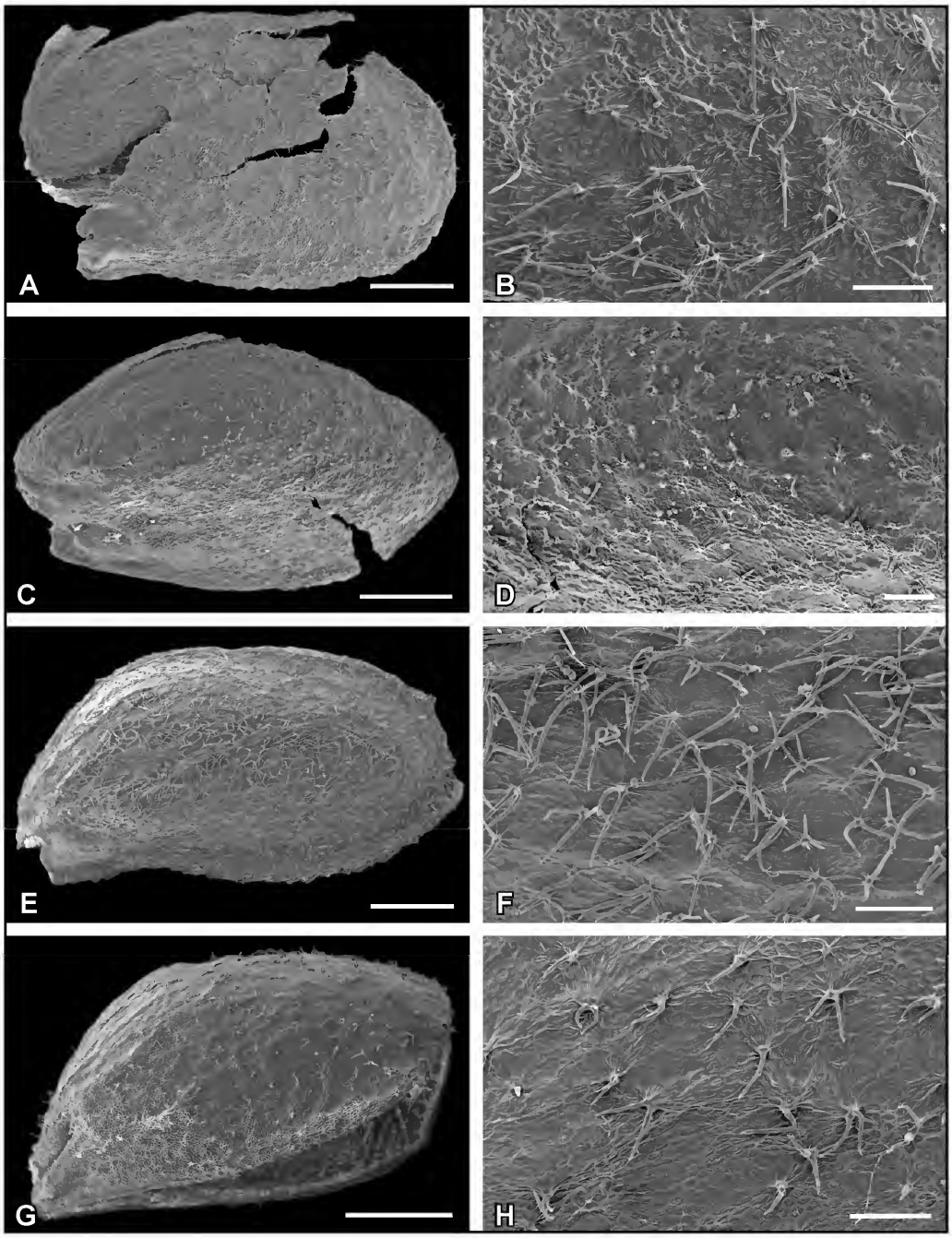

Figure 7. SEM images of a single valve of coccus from capsule (A, C, E, G) and coccus indumentum (B, D, F, H). A, B – *Boronia interrex* (sparse, simple and stellate hairs); C, D – *B. kalumburuensis* (old coccus valve with many ray branches broken off near the base); E, F – *B. marcoana* (sparse to moderately dense, stellate or rarely simple hairs); G, H – *B. thedae* (scattered simple and stellate hairs on surface with longer simple hairs on the inner and apical margins of the valves). Scale bars = 500 µm (A, C, E, G); 200 µm (B, D, F, H). Images from *R.L. Barrett & M.D. Barrett* RLB 1663 (A, B), *M.D. Barrett & R.L. Barrett* MDB 3119 (C, D), *R.L. Barrett & M.D. Barrett* RLB 6830 (E, F) and *R.L. Barrett* RLB 8868 (G, H). Images by R.L. Barrett.

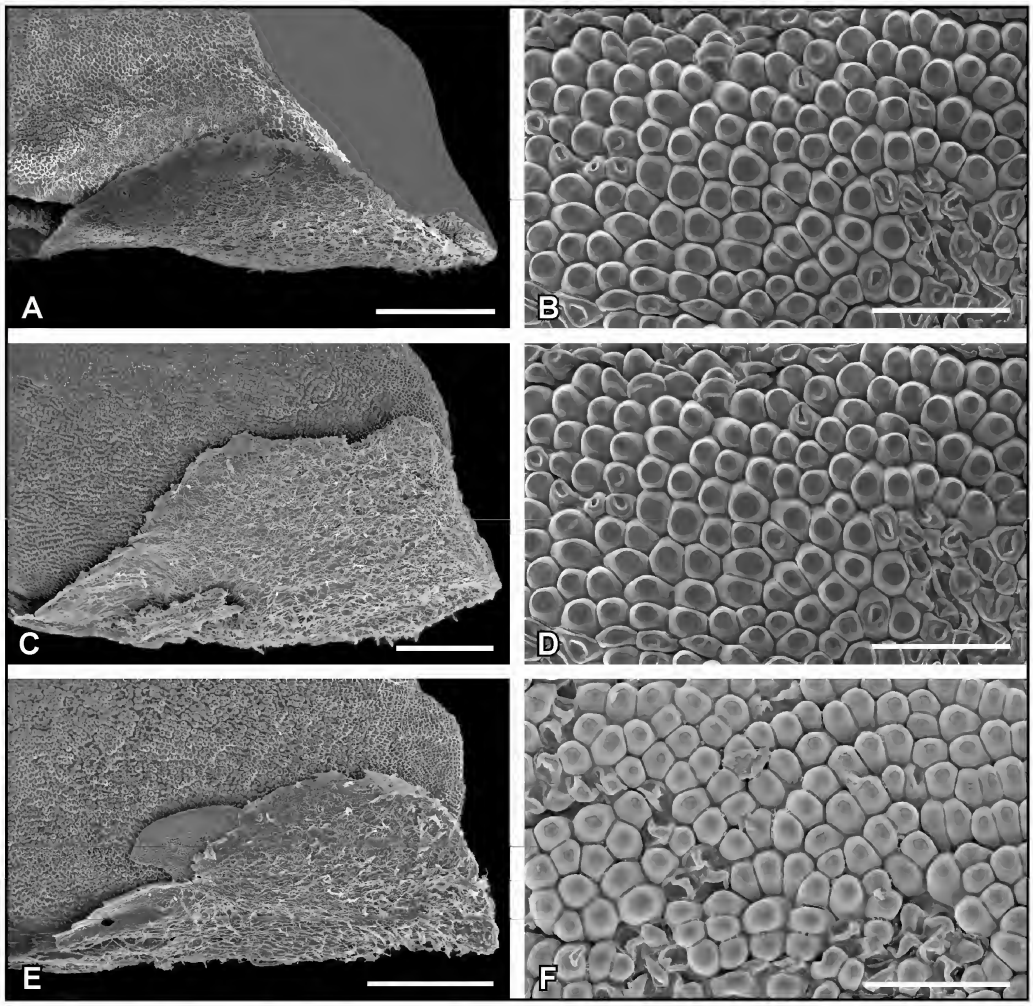

Figure 8. SEM images of elaiosome attached to seed (A, C, E) and seed surface from centre of seed (B, D, F). A, B – *Boronia interrex* (uniformly grey area in A represents broken portion of seed); C, D – *B. marcoana*; E, F – *B. thedae*. Scale bars = 500 µm (A, C, E); 100 µm (B, D, F). Images from *R.L. Barrett & M.D. Barrett* RLB 1663 (A, B), *R.L. Barrett & M.D. Barrett* RLB 6830 (C, D) and *R.L. Barrett* RLB 8868 (E, F). Images by R.L. Barrett.

indumentum, denser on young growth, and long, simple hairs. Multiangular *stellate hairs* sessile, with 4–10 rays; rays unicellular, unfused, firm, straight, not appressed, glossy, smooth, white, to 0.5 mm long. *Simple hairs* to 1.8 mm long. *Branches* terete, decurrencies absent, not obviously glandular, hairs distributed evenly, becoming glabrous with age, no cork development. *Leaves* opposite-decussate, imparipinnate with (1–)3–13 pinnae, not becoming unifoliolate with age, 7–27 mm long, 4–13 mm wide; lamina weakly discolorous, paler beneath, dorsiventral, indumentum moderately dense above, sparse beneath, denser when young, becoming sparsely hairy with age, not obviously glandular; margins entire, flat to slightly recurved; midribs of leaflets and rachis segments usually impressed adaxially, raised abaxially; pinnae subsessile, tip obtuse to acute; terminal pinnae ovate to oblanceolate or obovate, longer than laterals, 4–10 mm long, 2.3–4.5 mm wide, midvein straight; lateral pinnae opposite, elliptic to ovate, 3–7.5 mm long, 2–4.5 mm wide; rachis segments winged, narrowly triangular, distal end wider, 2.3–3.7 mm long, 0.5–1.2 mm wide; petiole not winged, 0.2–0.4 mm long; juvenile

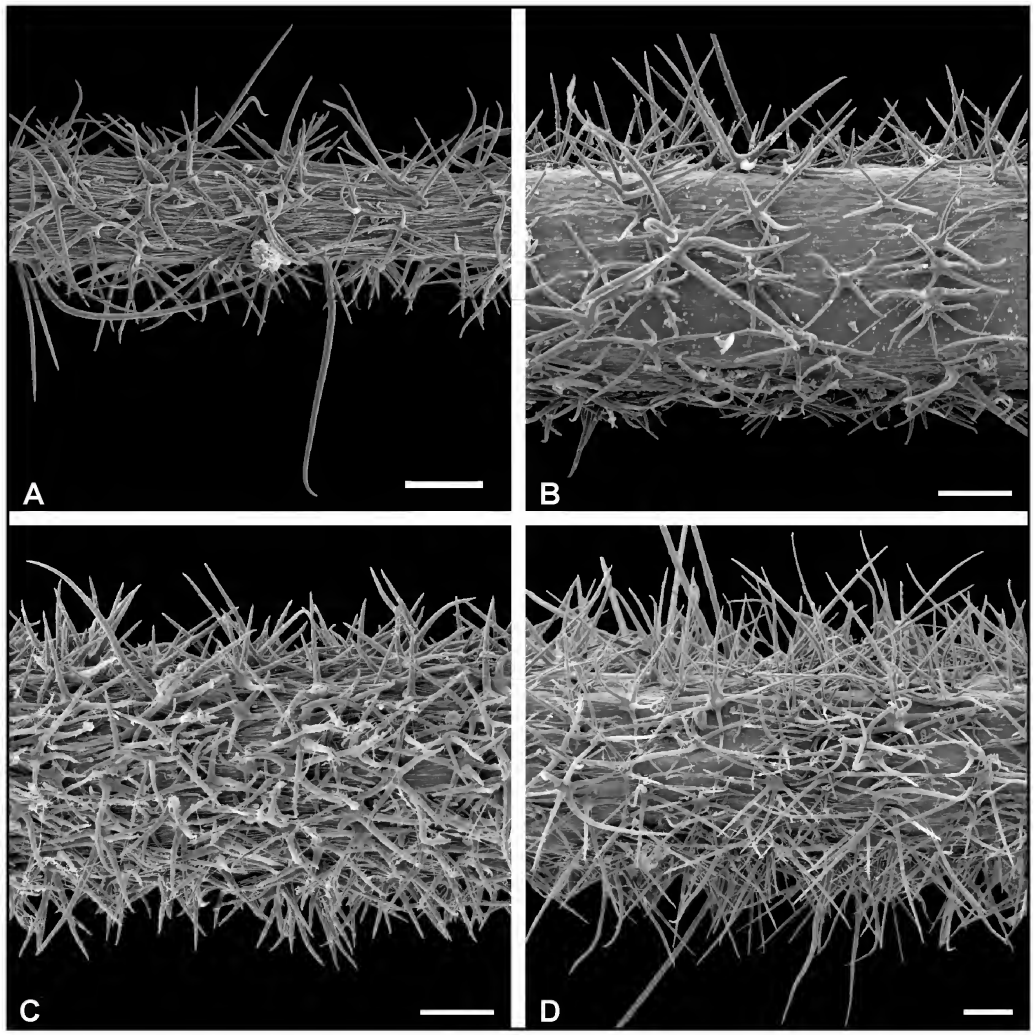

Figure 9. SEM images of indumentum on young stems. A – *Boronia interrex* (moderately dense indumentum of long simple and short stellate hairs); B – *B. kalumburuensis* (sparse to moderately dense indumentum of short stellate hairs); C – *B. marcoana* (dense indumentum of short stellate hairs); D – *B. thedae* (dense indumentum of moderately long simple and short stellate hairs). Scale bars = 200 μm. Images from *R.L. Barrett & M.D. Barrett* RLB 1663 (A), *M.D. Barrett & R.L. Barrett* MDB 3119 (B), *R.L. Barrett & M.D. Barrett* RLB 6830 (C) and *R.L. Barrett* RLB 8868 (D). Images by R.L. Barrett (A); M.D. Barrett (B–D).

leaves larger than mature leaves, terminal leaflet up to 15 mm long, 11 mm wide. *Inflorescence* cymose, 1-flowered; peduncle absent; prophylls to 0.4 mm long, persistent; anthopodium with a moderate to dense stellate indumentum, 4.5–13 mm long. *Sepals* longer and wider than petals, white or cream to pale pink, narrowly triangular to ovate-deltoid, acute to acuminate, 3.3–4.9 mm long, 1.1–1.5 mm wide, enlarging to 5.5 mm long with fruit, width similar; adaxial surface with dense stellate indumentum; abaxial surface with a moderately dense stellate indumentum. *Petals* pale to dark pink, 2.1–3.8 mm long, 1.0–1.5 mm wide, not elongating significantly with mature fruit, abaxial midrib not raised at base; adaxial surface with a a moderately dense to dense simple and stellate indumentum as well as scattered stalked glandular hairs, extending to the base; abaxial surface with a dense stellate indumentum. *Stamens* with filaments bearing simple hairs abaxially and on margins; antesepalous filaments clavate, suddenly narrowing to anther connective, 1.8 mm long, distal 0.9 mm swollen and

prominently glandular; antepetalous filaments bearing simple hairs abaxially and on margins, warty, 1.1 mm long; anthers with abaxial surface not frosty, antepetalous ones much larger than antesepalous; anther apiculum absent or minute, glabrous; pollen ovoid, *c.* 25 µm long, colpi lacking a central dome. *Ovary* glabrous; style hirsute for full length; stigma rounded, not or scarcely wider than style. *Cocci* with a sparse to moderately dense stellate (rarely simple) indumentum, 5.0–5.5 mm long, 2.5–2.9 mm wide, regularly only one or two cocci developing. *Seeds* with prominent ridge on adaxial side, shiny, black but mottled, 4.3–4.5 mm long, 1.9–2.3 mm wide; surface at magnification tuberculate; tubercles smooth, unfused, anticlinal walls ±visible, 15–40 µm across; elaiosome yellow-white, to 1.8 mm long. (Figures 4E, F; 5C; 6C; 7E, F; 8C, D; 9C; 10)

Diagnostic characters. Erect to spreading *shrub*. *Indumentum* of moderately dense to dense, mixed short stellate and long simple hairs on young growth. *Leaves* with (1–)3–13 pinnae, with a sparse stellate indumentum when mature. *Anthopodium* 4.5–13 mm long. *Petals* moderately to densely stellate hairy, denser abaxially, mixed with simple hairs on adaxial surface. *Cocci* with a sparse to moderately dense stellate indumentum.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 3 May 2011, *M.D. Barrett* MDB 3432 (PERTH); 12 Mar. 2014, *R.L. Barrett* RLB 8985 (BRI, CANB, DNA, MEL, NSW, PERTH).

Phenology. Flowering and fruiting recorded for late March. Probably January to May.

Distribution and habitat. Only known from two locations, the first near the Lawley River, east of the Mitchell Plateau, and the second on the King Edward River, south of Kalumburu. Found in fire protected sites, growing among massive broken sandstone boulders, often under rock overhangs, with associated species including *Acacia kelleri*, *Caesia setifera*, *Calytrix exstipulata*, *Calytrix* sp., *Corymbia torta*, *Eriosema chinense*, *Eucalyptus herbertiana*, *Grevillea refracta*, *Hibbertia scopata*, *Ipomoea* sp., *Micraira spiciforma*, *Monodia stipoides*, *Planchonia rupestris*, *Solanum* spp., *Stemodia* spp., *Stylidium saintpaulioides*, *Trichosanthes cucumerina* and *Triodia microstachya*.

Conservation status. *Boronia marcoana* is to be listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). Only known from two locations. One population is known from just outside Lawley River National Park and contains a small number of plants. Further surveys may locate this species within the reserve. A second extensive population is known from the King Edward River, about 25 km south-east of the first population.

Etymology. The epithet recognises the extensive work of Marco F. Duretto in documenting the genus *Boronia*, particularly in northern Australia.

Notes. The relatively few leaflets of *Boronia marcoana* provide a possible morphological link between subser. *Filicifoliae* and subser. *Lanuginosae*. Closely related to *B. interrex*, which has distinctly petiolate leaves, and to *B. kalumburuensis* and *B. thedae*, *B. marcoana* differs in the mature plants being erect to spreading, remaining green, the stem indumentum having short stellate hairs to 0.5 mm long and long simple hairs to 1.8 mm long, and petals one-half to two-thirds as long as sepals.

The vernacular name of Duretto's Boronia is suggested.

Figure 10. *Boronia marcoana*. A – habit among sandstone boulders; B – flowering branchlet, showing rachis segments widest at the distal end; C – lateral view of inflorescences in leaf axils; D – flowers showing variation in colour and shape of sepals and petals relative to B and E; E – close-up of sepals, petals and stamens; F – fruit. Images from *R.L. Barrett* RLB 8985 (A, C, D, F) and *R.L. Barrett & M.D. Barrett* RLB 6830 (B, E). Photographs by R.L. Barrett.

Boronia thedae R.L.Barrett, M.D.Barrett & Duretto, *sp. nov.*

Type: Theda Station [precise locality withheld for conservation reasons], Western Australia, 9 March 2014, *R.L. Barrett* RLB 8868 (*holo*: PERTH 08614709; *iso*: AD, BM, BRI, CANB, DNA, HO, K, MEL, NSW, PERTH 08615039).

Erect when young or supported by vegetation, branches decumbent to prostrate with age, many-branched *shrub* to 50(–100) cm high and 150 cm wide, mature growth red-green to purple-red in appearance in sun-exposed positions; with an *indumentum* of long, simple hairs and sparse to moderately dense stellate hairs, which are dense on young growth, becoming very sparse on mature leaflets. Multiangular *stellate hairs* sessile, with 2–6 rays; rays unicellular, unfused, firm, straight, not appressed, glossy, smooth, white, to 0.25 mm long. *Simple hairs* 0.6–0.9 mm long. *Branches* terete, decurrencies absent, not obviously glandular, hairs distributed evenly, becoming almost glabrous with age, no cork development. *Leaves* opposite decussate, imparipinnate with 5–15(–27) pinnae, not becoming unifoliolate with age, 12–29(–39) mm long, 7–12(–16) mm wide; lamina weakly discolorous, paler beneath, dorsiventral, indumentum usually sparse (densely hairy on immature leaves, soon moderately hairy, becoming very sparsely hairy with age), not obviously glandular; margins entire, flat to slightly recurved; midribs of leaflets and rachis segments usually impressed adaxially, raised abaxially; pinnae subsessile, tip obtuse to sub-acute; terminal pinnae oblanceolate to obdeltoid, longer than laterals, 4–9 mm long, 1.3–3.0 mm wide, midvein straight; lateral pinnae opposite or rarely sub-opposite, lanceolate to elliptic, 3–7 mm long, 1.2–2.7 mm wide; rachis segments winged, narrowly triangular, distal end wider, 2.0–3.8 mm long, 0.6–1.2 mm wide; petiole not winged, 0.5–0.9 mm long; juvenile leaves larger than mature leaves, terminal leaflet up to 17 mm long, 3.8 mm wide, moderately hairy. *Inflorescence* cymose, 1(2)-flowered; peduncle absent; prophylls to 0.9 mm long, persistent; anthopodium with a very sparse stellate and simple indumentum, 4.7–21.3 mm long, distally flared. *Sepals* longer and wider than petals, white or cream to pale pink, narrowly triangular to ovate-deltoid, acute to acuminate, 4.3–4.7 mm long, 1.0–1.5 mm wide, enlarging to 5.8 mm long with fruit, width similar; adaxial surface with dense stellate indumentum; abaxial surface with a moderately dense to sparse stellate indumentum. *Petals* creamy white to pale pink, usually dark pink at the base, 2.9–3.5 mm long, 1.2–1.5 mm wide, elongating to 4.8 mm long with mature fruit, abaxial midrib not raised at base; adaxial surface with a moderately dense to dense simple and stellate indumentum as well as scattered, stalked glandular hairs, extending to the base; abaxial surface with a sparse to moderately dense stellate indumentum. *Stamens* with filaments bearing simple hairs abaxially and on margins; antesepalous filaments clavate, suddenly narrowing to anther connective, 1.3 mm long, distal 0.7 mm swollen and prominently glandular; antepetalous filaments bearing simple hairs abaxially and on margins, warty, 1.1 mm long; anthers with abaxial surface not frosty, antepetalous ones much larger than antesepalous; anther apiculum small, glabrous; pollen ovoid, *c.* 25 µm long, colpi lacking a central dome. *Ovary* glabrous; style sparsely hirsute for full length; stigma rounded, not or scarcely wider than style. *Cocci* with scattered simple and stellate hairs on surface with longer simple hairs on the inner and apical margins of the valves, occasionally glabrous, 4.5–5.9 mm long, 2.3–2.6 mm wide, regularly only 1 or 2 cocci developing. *Seeds* with prominent ridge on adaxial side, shiny, black but mottled, 3.7–4.1 mm long, 1.6–1.8 mm wide; surface at magnification tuberculate; tubercles smooth, unfused, anticlinal walls ±visible, 10–40 µm across; elaiosome white, large, to 2.1 mm long. (Figures 4G, H; 5D; 6D; 7G, H; 8E, F; 9D; 11)

Diagnostic characters. Erect to decumbent to prostrate *shrub*, mature growth red-green to purple-red in appearance. *Indumentum* of sparse to moderately dense, mixed short stellate and long simple hairs. *Leaves* with 5–15(–27) pinnae, with a very sparse stellate indumentum. *Lateral pinnae* lanceolate to elliptic, 3–7 mm long, 1.2–2.7 mm wide. *Anthopodium* with a very sparse stellate and simple indumentum,

4.7–21.3 mm long. *Petals* moderately to densely stellate hairy above, sparsely to moderately densely stellate hairy below. *Cocci* glabrous except with a few scattered hairs on the inner and apical margins of the valves, occasionally glabrous.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 28 Apr. 2008, *M.D. Barrett & R.L. Barrett* MDB 2168 (PERTH); 28 Apr. 2008, *M.D. Barrett & R.L. Barrett* MDB 2177 (PERTH); 22 May 2009, *R.L. Barrett* RLB 5706 (PERTH); 11 Mar. 2014, *R.L. Barrett* RLB 8936 (CANB, DNA, MEL, NSW, PERTH); 24 July 1984, *S.J. Forbes* 2722 (MEL); 18 June 1985, *P.A. Fryxell, L.A. Craven & J. McD. Stewart* 4858 (CANB, MEL, PERTH).

Phenology. Flowering and fruiting recorded for April to July.

Distribution and habitat. Only collected from near Theda Station homestead over a range of about 5 km, but known to extend south-east for a distance of about 20 km to near the border of (but not within) Drysdale River National Park, to the north-west of Worriga Gorge, with semi-continuous populations observed from a helicopter over this range. While this area is still poorly collected, sufficient surveys have been undertaken by the authors to suggest that the known locations are an accurate reflection of the range of the species. It grows among massive broken boulders on sandstone ridges with *Acacia dacrydioides*, *A. kelleri*, *A. plectocarpa*, *Calytrix exstipulata*, *Corymbia torta*, *Eucalyptus herbertiana*, *E. rupestris*, *Grevillea microcarpa*, *Hibbertia* sp., *Ipomoea* sp., *Planchonia rupestris*, *Ptilotus giganteus*, *Solanum lasiophyllum*, *Stemodia lythrifolia*, *Stylidium saintpaulioides*, *Triodia* aff. *burbidgeana*, *T. claytonii* and *Triumfetta monstrosa*.

Conservation status. *Boronia thedae* is to be listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.).

Etymology. The epithet is derived from Theda Station, on the Kalumburu Road, where this species is found. Theda Station was apparently named for Theda, the wife of the founder of the station lease, so while the epithet recognises the station, this species is given a feminine epithet to reflect the history of its name.

Notes. Duretto (1997) and Duretto *et al.* (2013) included a few collections of *B. thedae* under *B. kalumburuensis*, including the first collection of this taxon made by S.J. Forbes in 1984.

Very closely related to *B. kalumburuensis*, *B. thedae* is most readily distinguished by the mature plants quickly becoming decumbent, and an indumentum of relatively dense, fine, mixed short stellate hairs up to 0.25 mm long and long simple hairs 0.6–0.9 mm long on stems. The density of hairs on the cocci varies in both species and both can occasionally be glabrous, but when hairy *B. kalumburuensis* has a denser, shorter indumentum than *B. thedae*. Comparison SEM images of *B. kalumburuensis* are provided in Figures 4–7 and 9. *Boronia kalumburuensis* remains poorly collected and better fertile collections are required to assess variation in coccus and seed features.

The vernacular name of Theda Boronia is suggested.

Figure 11. *Boronia thedae*. A – decumbent habit on sandstone; B – erect seedlings; C – flowering branchlet showing long anthopodium; D – leaf, showing sub-opposite pinnae (uncommon); E – flower; F – close-up of petals and stamens. Images from *R.L. Barrett* RLB 8868. Photographs by R.L. Barrett.

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Seven new species of *Haemodorum* (Haemodoraceae) from the Kimberley region of Western Australia

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Abstract

Barrett, R.L., Hopper, S.D., Macfarlane, T.D. and Barrett, M.D. Seven new species of *Haemodorum* (Haemodoraceae) from the Kimberley region of Western Australia. *Nuytsia* 26: 111–125 (2015). *Haemodorum basalticum* R.L.Barrett, Hopper & T.Macfarlane, *H. capitatum* R.L.Barrett & Hopper, *H. condensatum* Hopper & R.L.Barrett, *H. griseofuscum* R.L.Barrett, M.D.Barrett & Hopper, *H. interrex* R.L.Barrett & M.D.Barrett, *H. macfarlanei* R.L.Barrett and *H. thedae* R.L.Barrett are described as new species. *Haemodorum basalticum* and *H. macfarlanei* are restricted to the Mitchell Plateau, *H. capitatum* is restricted to pindan sands in the Dampier Botanical District, *H. condensatum* is known from a small area in the remote Prince Regent National Park, *H. griseofuscum* is only known from a single location on Doongan Station in Western Australia, although possibly also occurs in the Northern Territory, *H. interrex* is restricted to the area around the headwaters of the Prince Regent River, and *H. thedae* is only known from Theda Station. A key is presented to all species known to occur in the Kimberley region, and *H. subvirens* F.Muell. and *H. coccineum* R.Br. are newly recorded for the region.

Introduction

Seven new species of *Haemodorum* Sm. from northern Australia are described for the Kimberley region of Western Australia. *Haemodorum basalticum* R.L.Barrett, Hopper & T.Macfarlane was recognised as *H.* sp. A by Wheeler (1992) and is formally described here, along with *H. macfarlanei* R.L.Barrett and *H. thedae* R.L.Barrett, all endemic to basalt soils between the Mitchell Plateau and Theda Station. *Haemodorum capitatum* R.L.Barrett & Hopper is named from pindan sands around the Dampier Peninsula. *Haemodorum condensatum* Hopper & R.L.Barrett and *H. interrex* R.L.Barrett & M.D.Barrett are based on a small number of collections from the Prince Regent River area. *Haemodorum griseofuscum* R.L.Barrett, M.D.Barrett & Hopper is only known from a single location on Doongan Station in the north-west Kimberley. The genus has previously been reviewed for Australia by Macfarlane (1987), with 20 species recognised and for the Kimberley region by Wheeler (1992) who recognised five species in the region. However, both studies had limited material available and no opportunity for fieldwork in the Kimberley region.

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Monographic studies by S.D. Hopper and colleagues have resulted in the resurrection (see APNI 2015) of *H. subvirens* F.Muell. described by Mueller (1858) and *H. flavescens* W.Fitzg. described by Fitzgerald (1918). *Haemodorum subvirens* is a new record for the Kimberley region (*K.F. Kenneally* 10993, PERTH and *A.C. Beauglehole* ACB 54058, MEL, PERTH), as is *H. coccineum* R.Br., which has been collected on El Questro Station (*G. Byrne* 3453, PERTH). Additional new species await description from the Northern Territory and Queensland. Further studies are particularly needed in the *H. flaviflorum* W.Fitzg., *H. gracile* T.Macfarlane and *H. parviflorum* Benth. species complexes in Western Australia, as it is likely that additional taxa should be recognised in each of these. There is a need for further research and collection of *Haemodorum* in the Kimberley before an adequate understanding of the genus is available.

The present paper highlights the Kimberley region of Western Australia as a major centre of diversity for *Haemodorum*, with 14 species now recognised there, almost half the species in the genus. At least seven of these are considered to be endemic to the Kimberley region, the remainder also occurring in the Northern Territory, and some extending to northern Queensland. Most tropical *Haemodorum* species flower early in the wet season when access is difficult and environmental conditions are challenging, limiting collection of good specimens. Targeted collections should be made at this time of year to assess regional variation in the more difficult species complexes. Geophytic species often respond quickly to breaking rains in tropical Australia and their diversity appears to have been overlooked in this region. *Haemodorum* is now the most species-rich geophyte genus known in the Kimberley region.

Methods

Descriptions and illustrations are based on herbarium material. All new species described here have been examined in the field by at least the first author.

Key to Kimberley *Haemodorum* species

Note: Two species are keyed both ways at step 3 due to the degree to which some leaves are flattened and extremes of width. Most specimens will readily key either way.

1. Inflorescence 5–10 cm tall, a compact raceme, much shorter than the leaves **2**

1: Inflorescence (40–)60–175 cm tall, racemose, corymbose or paniculate, exceeding the leaves **3**

2. Leaves terete to subterete; flowers blackish red; inflorescence dense ..... **H. brevicaule**

2: Leaves narrowly elliptic in transverse section and finely ribbed; flowers grey-brown; inflorescence not dense ..... **H. griseofuscum**

3. Leaves ±flat in transverse section, (0.9–)1.8–8 mm wide **4**

3: Leaves terete to subterete, usually 0.6–1.2 mm wide (rarely to 2.5 mm wide in *H. condensatum*) **12**

4. Flowers yellowish green; leaves very bright green ..... **H. subvirens**

4: Flowers brown, orange or red; leaves dark green to dull bluish green **5**

5. Inflorescence with terminal flower clusters 1–few, capitate; leaves 0.9–2.5 mm wide ..... **H. capitatum**

5: Inflorescence an open panicle of well-spaced flowers, or when dense, a raceme, ±flat-topped corymb or series of corymbs; leaves (1–)1.8–8 mm wide **6**

6. Flowers yellow-orange to dull orange; inflorescence an open corymb ..... **H. basalticum**

6: Flowers bright orange-red to red to brown or aging to reddish (but bright orange-yellow to reddish in *H. macfarlanei*); inflorescence a dense corymb, open panicle or compound raceme. **7**

7. Leaves flat or subterete, 1–3.3 mm wide; inflorescence a raceme or compound raceme; flowers yellow to bright orange-red to red **8**

7: Leaves flat, 4–8 mm wide; inflorescence a dense corymb or open panicle; flowers dull red to orange-red to brown, red-brown or bright red **10**

8. Leaves flat to subterete; flowers pale yellow when fresh, maturing red, densely packed on the inflorescence ..... **H. condensatum**

8: Leaves flat; flowers bright orange to red when fresh, maintaining colour or becoming darker with age, well-spaced on the inflorescence **9**

9. Leaves 0.6–0.8(–1.1) mm wide; flowers 4–5.5 mm long, bright yellow-orange to reddish, with a pair of subtending bracteoles ..... **H. macfarlanei**

9: Leaves (1.6–)1.8–3.3 mm wide; flowers 5.2–7.1 mm long, brilliant orange-red to dark red, with a single subtending bracteole ..... **H. thedae**

10. All flowers well-spaced along inflorescence branches; flowers dull red to orange-red to brown, often with dull green basal parts ..... **H. ensifolium**

10: Flowers in close terminal clusters (dense panicle) on well-spaced inflorescence branches; flowers bright red to dark red-brown **11**

11. Flowers bright red; anthers 2.0–2.4(–3.7 in Queensland) mm long ..... **H. coccineum**

11: Flowers dark red-brown; anthers 2.6–3.5 mm long ..... **H. interrex**

12. Leaves flat or subterete, 1–2.5 mm wide; flowers pale yellow when fresh, maturing red, densely packed on the inflorescence ..... **H. condensatum**

12: Leaves ±terete (or flat to subterete in *H. macfarlanei*, but fresh flowers orange to red), 0.6–1(–1.2) mm wide; flowers yellow, greenish, orange or red, uniform in colour or darkening only slightly with maturity, well-spaced on inflorescence **13**

13. Flowers greenish yellow or yellow; inflorescence racemose ..... **H. flaviflorum *s. lat.***

13: Flowers orange to red; inflorescence paniculate or few-branched and racemose **14**

14. Inflorescence a flat-topped panicle; flowers red ..... **H. gracile**

14: Inflorescence racemose, occasionally compound; flowers orange or red **15**

15. Flowers yellow-orange to reddish; inflorescence (1–)3–5-branched; on basalt ..... **H. macfarlanei**

15: Flowers red; inflorescence not or 1-branched; on sandstone ..... **H. parviflorum (WA syntype)***

*One of the syntypes of *H. parviflorum* is a Cunningham collection from Western Australia. It is not considered conspecific with the Northern Territory syntypes, but typification of the name is required to establish its correct application.

Taxonomy

Haemodorum basalticum R.L.Barrett, Hopper & T.Macfarlane, *sp. nov.*

Type: Mitchell Plateau, Western Australia [precise locality withheld for conservation reasons], 25 January 2010, *R.L. Barrett & M.D. Barrett* RLB 6444 (*holo*: PERTH 08614334; *iso*: BRI, CANB, DNA, NSW).

Haemodorum sp. A, J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, pp. 1014–1015, Figure 304E (1992).

Haemodorum sp. A Kimberley Flora (K.F. Kenneally 8639), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 17 April 2014].

Illustration. J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1013, Figure 304E (1992) [as *Haemodorum* sp. A].

Geophyte, 70–120 cm tall, with inflorescences exceeding the leaves; *bulb* 10–15 cm below soil surface, dark red. *Basal leaves* 2 or 3; lamina dark green, flat, 330–650 mm long, 2.2–4.3 mm wide. *Inflorescence* loosely corymbose, branching portion 150–570 mm long, with flowers clustered on short, slender axes for 5–15 mm, 3–9 flowers per unit, the flowers and bracteoles yellow-orange to dull orange. *Bracteoles* 1 in lower third to half of axis, 1 sessile or up to 0.9 mm below flower, narrowly ovate to elliptic, thin but not scarious, 1.6–2.5 mm long, only medial vein apparent, margins undifferentiated; upper bracteoles acute, extending up to one quarter of the flower length. *Flowers* 4.2–5.9 mm long; *pedicel* 2.0–5.0 mm long. *Sepals* narrowly triangular, obtuse, 3.6–5.2 mm long, slightly shorter than the petals. *Petals* linear, obtuse, 4.3–5.8 mm long. *Stamens* equal, level or slightly emergent from petals at anthesis by 0.6 mm; filaments 2.4–3.3 mm long, partially enclosed by petals when dry; anthers yellow-orange to almost white at anthesis, erect and held vertically, 1.6–1.9 mm long. *Style* at anthesis pale with darker apex, 4.3–4.8 mm long, emergent 0.3–0.6 mm from petals. *Fruits* chocolate brown to black, 3.7–5.7 mm long, 5.5–9.4 mm wide. *Seeds* black, circular in outline; body broadly ovate in outline, *c.* 2 mm wide; wing 0.5–1.2 mm wide. (Figure 1)

Diagnostic characters. *Leaves* flat, 2.2–4.3 mm wide. *Inflorescence* loosely corymbose, flowers clustered on short, slender axes for 5–15 mm. *Flowers* yellow-orange to dull orange. *Habitat* on basalt soils.

Specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 23 Apr. 1977, *H. Eichler* 22452 (CANB, DNA); 17 May 1978, *K.F. Kenneally* 6656 (MEL, PERTH); 7 Feb. 1979, *K.F. Kenneally* 7062 (CANB, CNS, DNA, PERTH); 6 Dec. 1982, *K.F. Kenneally* 8639 (CANB, CNS, PERTH).

Phenology. Flowering and fruiting recorded from December to February.

Distribution and habitat. Endemic to the north Kimberley of Western Australia, where it is known only from basalt soils over laterite or massive basalt sheets in the Mitchell Plateau to Theda Station area. Occurs in eucalypt woodland with *Terminalia fitzgeraldii* and *Livistona eastonii* as associated species.

Conservation status. *Haemodorum basalticum* is to be listed as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). Of restricted distribution on the Mitchell Plateau; probably more common in the area than collections suggest, but poorly known.

Figure 1. *Haemodorum basalticum*. A – flat leaves; B – yellow-orange flowers and developing red-brown fruits in the loosely corymbose inflorescence; C – close-up of flowers at apex of inflorescence. Images from *R.L. Barrett & M.D. Barrett* RLB 6444. Photographs by R.L. Barrett.

Etymology. Derived from the basalt substrate on which this species grows.

Notes. This is one of four species in the region known to occur on basaltic soils, the other three being *H. gracile*, *H. macfarlanei* and *H. thedae*. Most species are restricted to sandy soils. It is similar to *H. flaviflorum* in flower form, but is more like *H. ensifolium* in inflorescence structure, differing from both in having yellow-orange to orange flowers.

Haemodorum basalticum was first discovered by K.F. Kenneally in 1979, but it was not recognised as a distinct species until the treatment of Wheeler (1992). Recent collections have enabled it to be formally described here.

Haemodorum capitatum R.L.Barrett & Hopper, *sp. nov.*

Type: [north-east of Broome,] Western Australia [precise locality withheld for conservation reasons], 26 November 2013, *R.L. Barrett & C. Bennison* RLB 8315 (*holo*: PERTH 08614385; *iso*: BM, BRI, CANB, DNA, K, MEL, NSW).

Geophyte, 60–90 cm tall, with inflorescences exceeding the leaves; *bulb* 15–23 cm below soil surface, dark red. *Basal leaves* 1–3; lamina dark green, flat, 40–60 cm long, 0.9–2.5 mm wide. *Scape* to 90 cm tall, *bracts* broad, green, 25–62 mm long, 2.5–5.0 mm wide. *Inflorescence* very compact, flowering portion 45–180 mm long, forming a tight cluster of 1–few capitate heads on peduncles 3–17 mm long, flowers arranged very close together along the slender axes for 3–8 mm, 8–41 flowers per unit, the flowers and bracteoles maroon or dark red to scarlet. *Bracteoles* narrowly ovate to elliptic, thin but not scarious, 2.1–9.5 mm long, the 3 or 5 veins obscure abaxially, margins undifferentiated; upper bracteoles acute, extending up to half of the flower length. *Flowers* 3.1–4.3 mm long; *pedicel* 0.5–1 mm long (extending up to 4 mm long in fruit). *Sepals* narrowly triangular, obtuse, 3.7–4.2 mm long, slightly shorter than the petals. *Petals* linear to narrowly triangular, obtuse to acute, 4.5–5.2 mm long. *Stamens* equal, slightly emergent from petals at anthesis by 1 mm; *filaments* 1.8–2.7 mm long, enclosed by petals when dry; *anthers* pale yellow to orange-yellow at anthesis, erect and held vertically, shortly exserted from petals, *c.* 2 mm long. *Style* at anthesis red with maroon apex, entire or shortly bifid, 4.1–4.7 mm long, equal to or emergent to 0.7 mm from petals. *Fruits* dark chocolate brown, 6–7 mm long, 7–10 mm wide. *Seeds* not seen. (Figure 2)

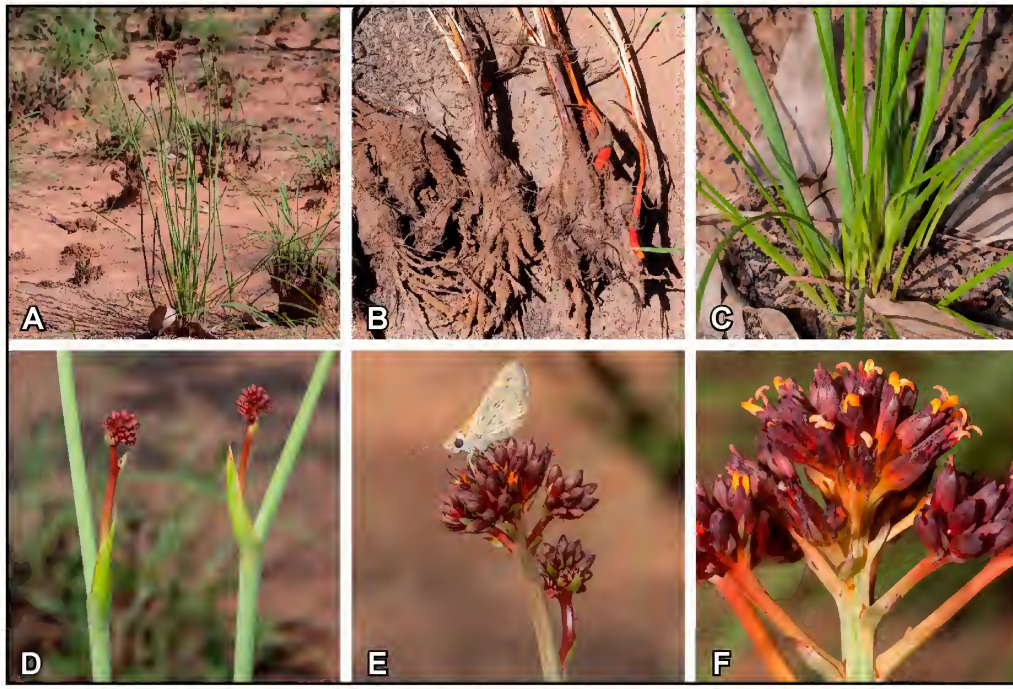

Figure 2. *Haemodorum capitatum*. A – habit; B – excavated bulbs; C – leaf and inflorescence bases; D – budding inflorescences and inflorescence bracts; E – compact inflorescence; F – flowers. Images from *R.L. Barrett & C. Bennison* RLB 8315. Photographs by R.L. Barrett.

Diagnostic characters. *Leaves* flat, 0.9–2.5 mm wide. *Inflorescence* a compact cluster of capitate heads. *Flowers* maroon or dark red to scarlet, sepal and petal apices obtuse.

Specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 22 Aug. 1985, *K.F. Kenneally* 9477 (CANB, PERTH); 24 Aug. 1985, *K.F. Kenneally* 9492 (NSW, PERTH); 18 Nov. 1984, *T. Willing* 155 (PERTH).

Phenology. Flowering recorded for August and November.

Distribution and habitat. Endemic to the south-west Kimberley of Western Australia, where it is known only from low depressions on pindan sand plains on grey and white sands. Associated species include *Corymbia polycarpa*, *Crotalaria crispata*, *Eucalyptus tectifica*, *Melaleuca acacioides*, *Terminalia canescens* and *Verticordia verticillata*.

Conservation status. *Haemodorum capitatum* is to be listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). Currently only known from four locations and not known from any conservation reserves.

Etymology. The epithet is from the Latin *capitus* (head) in reference to the very compact, head-like inflorescence structure.

Notes. The relationships of this distinctive species probably lie with *H. gracile*, which also has small red flowers with obtuse sepal and petal apices. The flat leaves and broad inflorescence bracts bear

some resemblance to *H. coccineum*, but that species has broader leaves and much larger flowers which have acute sepal and petal apices.

Haemodorum capitatum was first collected by T. Willing in 1984 and recognised as a distinct species by R.L. Barrett while conducting fieldwork supported by Buru Energy in 2013.

Further studies of *H. gracile s. lat.* are required, as the type collection is from basalt soils on the Mitchell Plateau, while all other collections are from sandstone habitats much further south.

Haemodorum condensatum Hopper & R.L.Barrett, *sp. nov.*

Type: north of Bachsten Creek Falls, Prince Regent Nature Reserve [National Park], Western Australia [precise locality withheld for conservation reasons], 18 January 2010, *R.L. Barrett, M. Maier & P. Kendrick* RLB 6239 (*holo*: PERTH 08614628; *iso*: BRI, CANB, DNA, K, MEL).

Haemodorum sp. Gardner Plateau (R.L. Barrett & M.D. Barrett RLB 1008), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 17 April 2014].

Geophyte, 50–75 cm tall, with inflorescences exceeding the leaves; *bulb* 7–8 cm below soil surface, scarlet. *Basal leaves* 4 or 5; lamina dark green, flat or subterete, to 30–60 cm long, 1–2.5 mm wide. *Inflorescence* a dense raceme or few-branched panicle with the ultimate branches racemose, 160–180 mm long, and single flowers distributed evenly along the slender axes for 25–65 mm, 14–36 flowers per unit, the flowers and bracteoles yellow when fresh, aging blackish red. *Bracteoles* acute, thin but not scarious, 2–3 mm long, the 3 veins obscure abaxially, margins undifferentiated; upper bracteoles acute, extending up to half of the flower length. *Flowers* 4–5 mm long; *pedicel* 1–2 mm. *Sepals* linear, acute, 3–3.5 mm, as long as petals. *Petals* linear, obtuse, 3–3.5 mm long. *Stamens* equal, level with to slightly emergent from petals at anthesis by *c.* 0.2 mm; *filaments c.* 1.5 mm long; *anthers* erect and held vertically, not prominently exserted from petals, 1.2–1.3 mm long. *Style* at anthesis 4.5–5 mm long, *emergent* 1–1.5 mm from petals. *Fruits* dark chocolate brown, 4–6 mm long, 6–9 mm wide. Immature *seeds* black, circular in outline; body broadly ovate in outline, *c.* 2.1 mm wide; wing not formed on immature seeds. (Figure 3)

Diagnostic characters. *Leaves* flat to subterete, 1–2.5 mm wide. *Inflorescence* with many flowers condensed in a tight raceme 25–65 mm long. *Flowers* yellow, aging blackish red.

Specimen examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 4 Dec. 1994, *R.L. Barrett & M.D. Barrett* RLB 1008 (CANB, PERTH).

Phenology. Recorded for early December at the onset of the wet season and in late flower in mid-January. The first collection was from habitat that was not burnt the previous season.

Distribution and habitat. Endemic to the north Kimberley of Western Australia, where it is known only from two populations about 12 km apart in the southern Prince Regent National Park. Grows in open *Corymbia latifolia* woodland over *Triodia bitextura* on extensive sandstone flats below sandstone ridges. Associated species include *Calochilus caesius*, *Haemodorum brevicaule*, *H. gracile*, *Murdannia graminea*, *Sorghum plumosum*, *Tacca maculata* and *Terminalia ferdinandiana*.

Figure 3. *Haemodorum condensatum*. A – habitat at type location; B – habit; C – few-branched panicle with dense flowers and fruits. Images from *R.L. Barrett, M. Maier & P. Kendrick* RLB 6239. Photographs by R.L. Barrett.

Conservation status. *Haemodorum condensatum* is listed by Jones (2014) as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *Haemodorum* sp. Gardner Plateau (R.L. Barrett & M.D. Barrett RLB 1008).

Etymology. Named from the Latin *condensatus*, alluding to the condensed racemose inflorescences compared to those of *H. flaviflorum*, which have more widely-spaced flowers.

Notes. *Haemodorum condensatum* is a rare and poorly known species of the Kimberley. It is most similar to *H. flaviflorum*, from which it differs in its compressed leaves, its many flowers condensed in a tight raceme 25–65 mm long, and its flowers which age blackish red. *Haemodorum flaviflorum* was treated as *H. parviflorum* by Wheeler (1992) but the latter is a Northern Territory endemic.

Haemodorum condensatum was discovered by R.L. and M.D. Barrett while hiking near Bachsten Creek in 1994, then not relocated until targeted surveys were made nearby in 2010 by R.L. Barrett, M. Maier and P. Kendrick.

Haemodorum griseofuscum R.L.Barrett, M.D.Barrett & Hopper, *sp. nov.*

Type: cultivated: [at] Kings Park [and Botanic Garden, Perth, from material collected on Doongan Station], Western Australia [precise locality withheld for conservation reasons], 17 February 2013, *M.D. Barrett* MDB 4002 (*holo*: PERTH 08614350; *iso*: DNA).

Geophyte, 40–60 cm tall, with inflorescences greatly exceeded by leaves; *bulb* 6–10 cm below soil surface, dark red. *Basal leaves* 5–10; lamina dark green, compressed-ovoid in TS, finely ribbed, 30–60 cm long, (0.7–)1.0–2.2 mm wide (to 3.5 mm wide when fresh). *Inflorescence* very compact, an unbranched or once-branched raceme, 30–40 mm long, flowers distributed very close together along the robust axes for 15–20 mm, 14–18 flowers per inflorescence, the flowers and bracteoles grey-brown, tepals with dark brown to black apices. *Bracteoles* linear to narrowly elliptic, thin but not scarious, *c.* 6 mm long, the 3 veins obscure abaxially, margins undifferentiated; upper bracteoles acute, extending up to half of the flower length. *Flowers* 5–8 mm long, sessile above a pair of bracteoles with a *pedicel* 1.6–2.3 mm long below the bract. *Sepals* narrowly ovate, obtuse, 3.1–4.5 mm long, *c.* 1.5 mm shorter than the petals. *Petals* linear to narrowly oblong, obtuse, 4.5–7.0 mm long. *Stamens* equal, included within petals at anthesis; *filaments* 3.5–4.0 mm long, enclosed by petals when dry; *anthers* yellow-orange at anthesis, erect and held vertically, shorter than petals, *c.* 1.1 mm long. *Style* at anthesis red, 4.0–4.5 mm long, included by *c.* 0.8 mm from petals. *Fruits* not seen. *Seeds* not seen. (Figure 4)

Diagnostic characters. *Leaves* compressed, finely ribbed, (0.7–)1.0–2.2 mm wide when dry. *Inflorescence* very much shorter than the leaves, compact, forming a very dense raceme 30–40 mm long. *Flowers* grey-brown with dark brown to black apices, 5–8 mm long, sepal and petal apices obtuse.

Specimen examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 17 May 2011, *R.L. Barrett* RLB 7233 (PERTH).

Phenology. Flowering not known in the field in Western Australia; cultivated material flowered in February.

Distribution and habitat. Possibly endemic to the north-west Kimberley of Western Australia, where it is known only from sand in *Eucalyptus miniata* and *E. tetrodonta* woodland, growing with *Arthrostylis* aff. *aphylla*, *Commelina cyanea*, *Goodenia* sp., *Minuria macrorhiza*, *Mitrasacme kenneallyi*, *Polycarpaea corymbosa*, *Stemodia lythrifolia* and *Vigna* sp.

Conservation status. *Haemodorum griseofuscum* is to be listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.).

Etymology. The epithet is derived from the Latin *griseus* (grey) and *fuscus* (brown), in reference to the distinctive flower colour in this species.

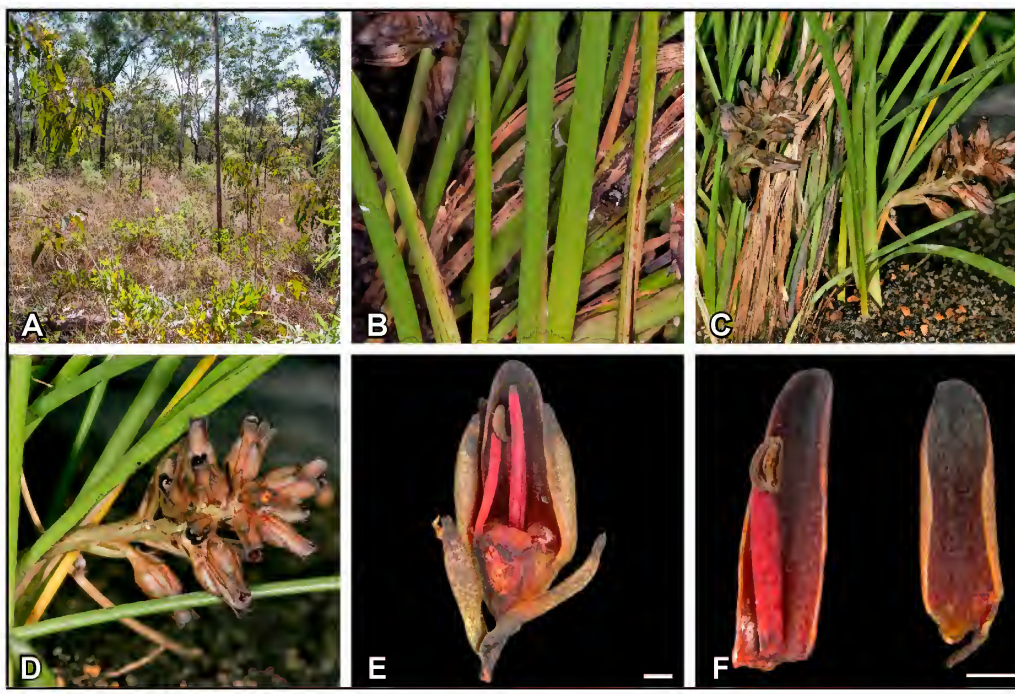

Figure 4. *Haemodorum griseofuscum*. A – habitat at type's original location; B – leaf bases; C – leaf bases and inflorescences; D – compact racemose inflorescence; E – partially dissected flower; F – tepals, staminal filament and old anther. Images from *R.L. Barrett* RLB 7233 (A) and *M.D. Barrett* MDB 4002 (B–F). Photographs by R.L. Barrett (A); M.D. Barrett (B–F).

Notes. The relationships of this distinctive species probably lie with *H. brevicaule* F.Muell., which also has a very short, almost sessile, but much more condensed and cylindrical inflorescence. The inflorescence and flowers of *H. griseofuscum* are larger, and the flowers are grey-brown with dark apices rather than entirely reddish black.

Haemodorum griseofuscum was discovered as sterile plants by R.L. Barrett during flora and fauna surveys coordinated by C. Myers on Doongan and Theda Stations in 2011. Live plants were collected which were cultivated, and subsequently flowered, at Kings Park.

There are somewhat similar collections to the Western Australian material from south-west of Darwin in the Northern Territory (*S.T. Blake* 16529, BRI; *G. Leach et al.* 4651, DNA), but further work is required to determine whether these collections belong to *H. griseofuscum* or represent a distinct species. Both of these Northern Territory specimens were collected in late November and were in fruit at that time. Habitat was similar to *H. griseofuscum* and populations occurred in sandy, pale brown loam and laterite in a *Eucalyptus miniata* and *E. tetrodonta* woodland with *Acacia latescens*, *Cycas armstrongii* and *Livistona humilis*.

Haemodorum interrex R.L.Barrett & M.D.Barrett, *sp. nov.*

Type: north-north-west of Mount Agnes, West Kimberley, Western Australia [precise locality withheld for conservation reasons], 9 January 2001, *M.D. Barrett* MDB 1185 (*holo*: PERTH 07977611; *iso*: CANB, DNA, K).

Haemodorum sp. Prince Regent River (M.D. Barrett MDB 1185), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 17 April 2014].

Geophyte, 80–120 cm tall, with inflorescences exceeding the leaves; *bulb* 4–5 cm below soil surface, scarlet. *Basal leaves* 4 or 5; lamina dull green to bluish green, ±glaucous, flat, 17–60 cm long, 4.5–8.1 mm wide. *Inflorescence* a few-branched panicle with the ultimate branches forming dense corymbs, 90–280 mm long, flowers crowded at the apex of moderately thick axes for 5–10 mm, 4–13 flowers per unit, the flowers and bracteoles dark red-brown. *Bracteoles* acute, relatively thick, not scarious, 5–8 mm long, the 1–5 veins obscure abaxially, margins undifferentiated; upper bracteoles acute, extending up to one quarter of the flower length. *Flowers* 5.5–8.0 mm long; *pedicel* 1.1–2.8 mm. *Sepals* lanceolate to narrowly ovate, acute, 4.5–5.5 mm, shorter than petals. *Petals* linear to oblanceolate, acute or obtuse, 5.3–6.3 mm long, enlarged up to 7.5 mm in fruit. *Stamens* equal, level with petals at anthesis; *filaments* 2.3–2.5 mm long; *anthers* erect and held vertically, not prominently exserted from petals, 2.6–3.5 mm long. *Style* at anthesis 3.8–5.2 mm long, emergent 0.5–1.8 mm from petals. *Fruits* dark chocolate brown to black, 6.0–7.5 mm long, 5.7–10.7 mm wide, often only 1 or 2 carpels maturing. *Seeds* black-brown, ±circular in outline; body ovate in outline, 5.7–5.9 mm long, 3.5–3.7 mm wide; wing *c.* 0.8 mm wide. (Figure 5)

Diagnostic characters. *Leaves* flat, 4.5–8.1 mm wide. *Inflorescence* paniculate but with flowers in crowded clusters. *Flowers* dark red-brown, sepal and petal apices obtuse.

Specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 29 Jan. 2000, *M.D. Barrett* MDB 951 (CANB, DNA, K, PERTH); 2 Feb. 2000, *M.D. Barrett* MDB 1032 (CANB, DNA, K, PERTH); 12 Jan. 2001, *R.L. Barrett & M.D. Barrett* RLB 1770 (CANB, PERTH);

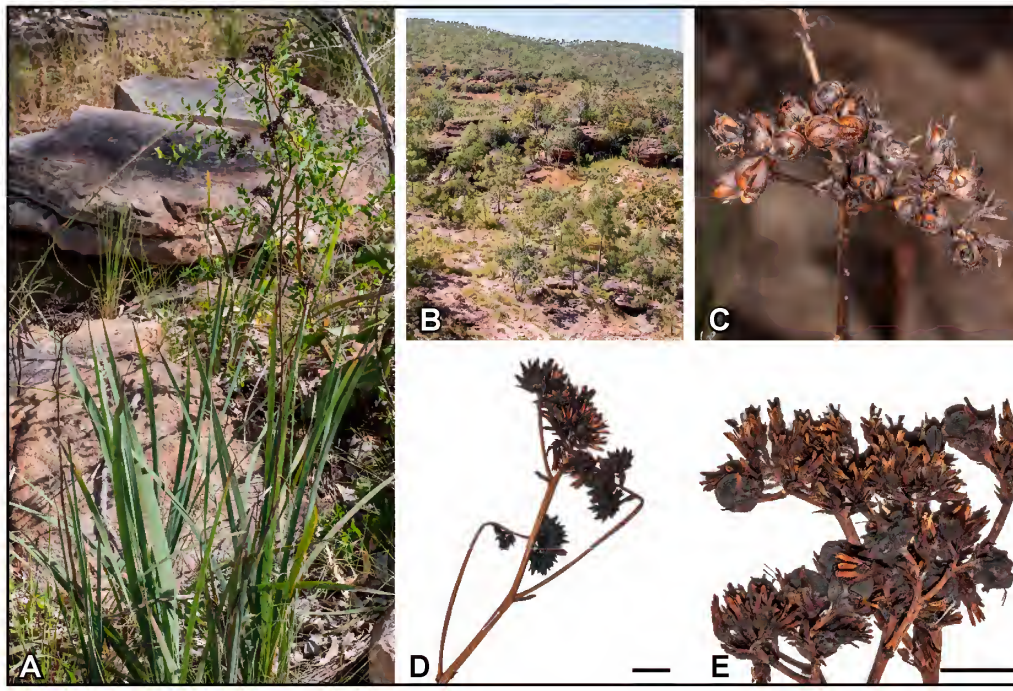

Figure 5. *Haemodorum interrex*. A – habit; B – habitat; C – few-branched paniculate infructescence; D – few-branched paniculate inflorescence; E – flowers in compact, corymbose clusters. Images from *R.L. Barrett & M.D. Barrett* RLB 4542 (A–C) and *M.D. Barrett* MDB 1185 (D, E). Scale bars = 1 cm. Photographs by R.L. Barrett.

19 Jan. 2003, *R.L. Barrett & M.D. Barrett* RLB 2588 (CANB, PERTH); 22 Apr. 2008, *R.L. Barrett & M.D. Barrett* RLB 4542 (PERTH); 13 June 1921, *C.A. Gardner* 874 (PERTH).

Phenology. Flowers and fruit recorded for January; probably fertile from December to March.

Distribution and habitat. *Haemodorum interrex* is only known from three populations near the headwaters of the Prince Regent River (all outside Prince Regent National Park) where it grows in open woodland on shallow sand over sandstone.

Conservation status. *Haemodorum interrex* is listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *Haemodorum* sp. Prince Regent River (M.D. Barrett MDB 1185). All known populations are small and the total known range is only 20 km across. The species is possibly sensitive to frequent fires.

Etymology. The epithet is from the Latin *interrex* (a regent, temporary king), in reference to the location of this species in the Prince Regent River area.

Notes. First collected by C.A. Gardner on the W. Easton Expedition in 1921 (Gardner 1923), *H. interrex* was rediscovered and first recognised as a new species by M.D. Barrett during surveys of the remote Prince Regent River area in 1999. It appears to be most closely related to *H. subvirens*, differing in the dull green to bluish green leaves and red-brown flowers (leaves bright green and flowers yellowish green in *H. subvirens*).

Haemodorum macfarlanei R.L.Barrett, *sp. nov.*

Type: Mitchell Plateau, North Kimberley, Western Australia [precise locality withheld for conservation reasons], 7 December 1982, *K.F. Kenneally* 8661 (*holo*: PERTH 03079392; *iso*: CANB 534407).

Geophyte, 30–65 cm tall, with inflorescences exceeding the leaves; *bulb* 4–5 cm below soil surface, dark red. *Basal leaves* 5–10; lamina dark green, flat or occasionally almost subterete, 25–65 cm long, 0.6–0.8(–1.1) mm wide. *Inflorescence* a 1–5-branched compound raceme, the ultimate branches racemose, 90–250 mm long, with single flowers well-spaced at the base, becoming crowded at the apex of the slender axes for 40–80 mm, 7–18 flowers per unit, the flowers and bracteoles bright orange-yellow to reddish. *Bracteoles* narrowly ovate to elliptic, thin but not scarious, 2.0–2.6 mm long, the 3–5 veins obscure abaxially, margins undifferentiated; upper bracteoles acute, not overlapping or extending up to half of the flower length. *Flowers* 4–5.5 mm long, sessile above a pair of bracteoles with a *pedicel* 1.7–14.6 mm long below the bracteoles. *Sepals* linear to lanceolate, obtuse to acute, 3.4–4.1 mm long, about the same length or slightly shorter than the petals. *Petals* linear to oblanceolate, obtuse to acute, 3.4–4.1 mm long. *Stamens* equal, shorter than petals at anthesis by 0.5–0.8 mm; filaments 1.4–2.5 mm long, enclosed by petals when dry; anthers yellow-orange to almost white at anthesis, erect and held vertically, shorter than petals, 1.3–1.6 mm long. *Style* at anthesis pale with dark apex, 3.5–5.6 mm long, emergent 0.3–1.8 mm from petals. *Fruits* chocolate brown to black, 5–6 mm long, 4–9 mm wide. *Seeds* not seen. (Figure 6)

Diagnostic characters. *Leaves* subterete to flat, 0.6–0.8(–1.1) mm wide. *Inflorescence* a several-branched raceme, flowers crowded in upper 40–80 mm. *Flowers* bright orange-yellow to reddish, 4–5.5 mm long, sessile above a pair of bracteoles. *Habitat* on basalt soils.

Specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 24 Jan. 2010, *R.L. Barrett & M.D. Barrett* RLB 6376 (CANB, DNA, PERTH); 27 May 1991, *T. Willing* 437 (PERTH).

Phenology. Flowering recorded for December, January and May.

Distribution and habitat. Endemic to the north Kimberley of Western Australia, where it is known only from basalt soils over laterite or massive basalt sheets on the Mitchell Plateau, often in sandy loam in runoff areas. Associated species include *Acacia paula*, *Banksia dentata*, *Chrysopogon fallax*, *Eucalyptus latifolia*, *E. tetrodonta*, *Livistona eastonii* and *Melaleuca nervosa*.

Conservation status. *Haemodorum macfarlanei* is to be listed as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). Of restricted distribution, with four populations known over a distance of about 50 km, in an area prospective for bauxite mining, but known to occur in the Camp Creek Conservation Reserve.

Etymology. The epithet recognises the work of Terry D. Macfarlane in revisionary work on *Haemodorum* and producing the *Flora of Australia* account of the genus (Macfarlane 1987).

Notes. One of four species in the region known to occur on basaltic soils, the other three being *H. basalticum*, *H. gracile* and *H. thedae*. It is like *H. flaviflorum* in inflorescence form, differing in having broader, flat leaves, and is also similar in inflorescence form to *H. thedae*, but differing in the more slender leaves, smaller, yellow-orange flowers and the pair of bracteoles subtending the flower

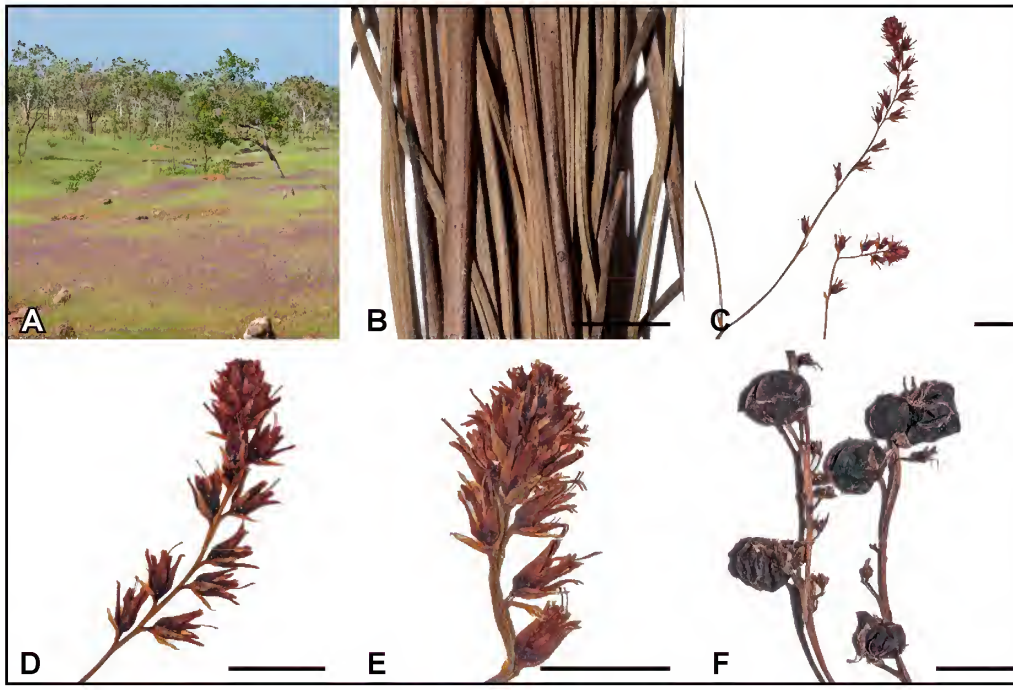

Figure 6. *Haemodorum macfarlanei*. A – habitat at type location; B – leaves; C – compound racemose inflorescence; D, E – racemose inflorescence showing floral bracts; F – racemose infructescence. Images from *R.L. Barrett & M.D. Barrett* RLB 6376 (A, F), *T. Willing* 437 (B–D) and *K.F. Kenneally* 8661 (E). Scale bars: B = 5 mm; C–F = 1 cm. Photographs by R.L. Barrett.

(*vs* 1 bracteole distantly subtending the flower in *H. thedae*). It is probably most closely related to *H. basalticum*, with which it occurs, but distinguished by a smaller stature and more slender leaves; also the inflorescence is a branching raceme rather than an open panicle.

Haemodorum macfarlanei was first discovered by K.F. Kenneally in 1982, but it was not recognised as a distinct species until a recent collection was made by R.L. and M.D. Barrett.

Haemodorum thedae R.L.Barrett, *sp. nov.*

Type: west-north-west of (new) Theda Homestead [Theda Station], North Kimberley, Western Australia [precise locality withheld for conservation reasons], 15 February 2005, *M.D. Barrett* MDB 1527 (*holo*: PERTH 08044163; *iso*: BRI, CANB, DNA, K, MEL).

Geophyte, 70–160 cm tall with inflorescences exceeding the leaves; *bulb* 8–9 cm below soil surface, dark red. *Basal leaves* 3–5; lamina dark green, flat, 48–81 cm long, (1.6–)1.8–3.3 mm wide. *Inflorescence* a compound raceme, 170–260 mm long, with individual flowers distributed evenly along the slender axes for 30–50 mm, 7–15(–25) flowers per unit, the flowers and bracteoles brilliant orange-red to dark red. *Bracteoles* narrowly ovate to elliptic, thin but not scarious, 1.5–3 mm long, the 3 veins obscure abaxially, margins undifferentiated; upper bracteoles acute, extending up to one third of the flower length. *Flowers* 5.2–7.1 mm long; *pedicel* 4.7–7.3 mm long. *Sepals* narrowly triangular, obtuse, 4.9–5.9 mm long, slightly shorter than the petals. *Petals* linear, obtuse, 5.2–6.7 mm long. *Stamens* equal, slightly emergent from petals at anthesis by 0.6 mm; filaments 2.6–4.5 mm long, enclosed by petals

when dry; anthers yellow-orange to almost white at anthesis, erect and held vertically, shortly exserted from petals, 1.5–1.8 mm long. *Style* at anthesis white with maroon apex, 4.6–6.1 mm long, emergent 0.8–1.5 mm from petals. *Fruits* chocolate brown to black, 5–6 mm long, 8–10 mm wide. *Seeds* black, circular in outline; body broadly ovate in outline, *c.* 3 mm wide; wing 0.5–1.5 mm wide. (Figure 7)

Diagnostic characters. *Leaves* flat, (1.6–)1.8–3.3 mm wide. *Inflorescence* a compound raceme, flowering portion 30–50 mm long. *Flowers* bright orange-red to dark red. *Habitat* on basalt soils.

Specimens examined. WESTERN AUSTRALIA [localities withheld for conservation reasons]: 21 Feb. 2005, *M.D. Barrett* MDB 1610 (AD, NSW, PERTH); 26 Aug. 2010, *M.D. Barrett & R.L. Barrett* MDB 3154 (NSW; PERTH).

Phenology. Flowering and fruiting recorded for February and observed to have finished by late March, but early flowering observed in August following an unseasonal rainfall event.

Distribution and habitat. Endemic to the north Kimberley of Western Australia, where it is known only from savannah woodland on basalt soils over massive basalt sheets in the Theda Station area. Associated species include *Corymbia greeniana*, *Eucalyptus tectifica*, *Livistona eastonii*, *Heteropogon contortus*, *Sorghum plumosum*, *Themeda triandra* and *Terminalia canescens*.

Conservation status. *Haemodorum thedae* is to be listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). Of restricted distribution with most of the known populations on roadsides or fence lines and thus subject to disturbance.

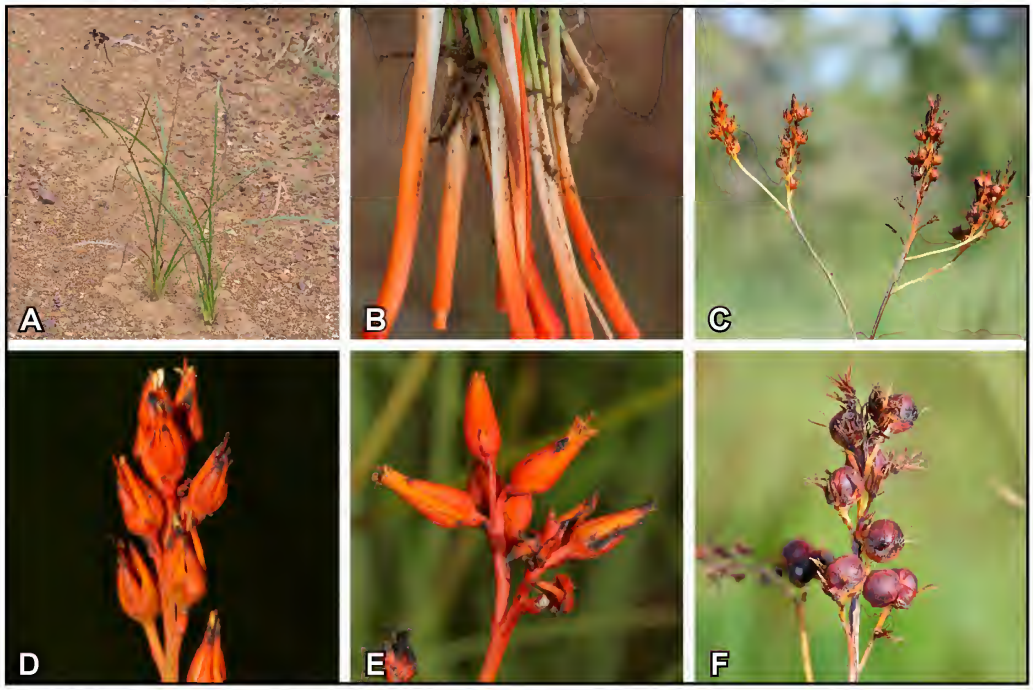

Figure 7. *Haemodorum thedae*. A – habit; B – stem bases; C – compound raceme with flowers and fruits; D, E – red flowers; F – fruits. Images from *M.D. Barrett* MDB 1610 (A, B, D) and *M.D. Barrett* MDB 1527 (C, E, F). Photographs by M.D. Barrett.

Etymology. The epithet is derived from Theda Station, on the Kalumburu Road, where this species is found. Theda Station was apparently named for Theda, the wife of the founder of the station lease, and this species is given a feminine epithet to reflect this.

Notes. This is one of four species in the region known to occur on basaltic soils, the other three being *H. basalticum*, *H. gracile* and *H. macfarlanei*. Most species are restricted to sandy soils. It is like *H. flaviflorum* in flower form and *H. macfarlanei* in inflorescence structure, differing from both in having broader, flat leaves. The compound raceme, large, orange-red to red flowers and moderately broad, flat leaves distinguish this species from all others in the region. Molecular data suggest that this species is most closely related to *H. basalticum*, which has a paniculate inflorescence and yellow-orange to dull orange flowers (R. Smith & S.D. Hopper in prep.).

Haemodorum thedae was first discovered by M.D. Barrett in 2005 during flora surveys on Theda Station

Acknowledgements

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Four new species of *Stylidium* (Stylidiaceae) from the Kimberley region of Western Australia

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Abstract

Barrett, R.L., Barrett, M.D., Kenneally, K.F. & Lowrie, A. Four new species of *Stylidium* (Stylidiaceae) from the Kimberley region of Western Australia. *Nuytsia* 26: 127–141 (2015). *Stylidium latrodectus* R.L.Barrett, M.D.Barrett & Lowrie, *S. pindanicum* R.L.Barrett, *S. saintpaulioides* R.L.Barrett, M.D.Barrett & Lowrie and *S. willingii* R.L.Barrett, Kenneally & Lowrie are described as new species from the Kimberley region of Western Australia. All species are illustrated and modified keys are presented.

Introduction

Four new species of *Stylidium* Sw. from the Kimberley region of northern Australia are described. *Stylidium latrodectus* R.L.Barrett, M.D.Barrett & Lowrie and *S. willingii* R.L.Barrett, Kenneally & Lowrie are reasonably widespread between Charnley River Station and Kalumburu. *Stylidium saintpaulioides* R.L.Barrett, M.D.Barrett & Lowrie is restricted in distribution between Theda Station, Kalumburu and the Lawley River. *Stylidium pindanicum* R.L.Barrett is restricted to the Dampier Botanical District.

Stylidium has been reviewed for northern Australia by Bean (1999, 2000, 2010), following the description of a series of new species by Lowrie and Kenneally (1996, 1997, 1998). Prior to this, the only available works on Kimberley triggerplants were those of Erickson (1958) and Wheeler (1992), both of which included less than half the number of taxa now known to occur in the region. This paper brings together the combined experience of four authors who began working together in 1992 to 'conquer new worlds' (see Erickson 1958: 172). While great advances have been made in the 'new world' of tropical triggerplants, numerous new species have come to light in recent decades that await formal recognition and description. Many of these taxa are short-lived ephemerals that grow on shallow sandy flats on sandstone in the north-west Kimberley in habitats that quickly dry out at the end of the wet season, meaning there is a very narrow seasonal window for their discovery and collection.

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Methods

Descriptions are based on herbarium specimens. All new species described here have been examined in the field by at least the first author. Specimens have been examined at BM, CANB, K, MEL, NSW and PERTH. Seeds and pollen grains were mounted on stubs using double-sided or carbon tape with conductive carbon paint, coated with gold using an EMITECH K550X Sputter Coater and imaged at high vacuum and high voltage (15 KVa) using a Jeol JCM 6000 NeoScope bench-top Scanning Electron Microscope at Kings Park and Botanic Garden.

Taxonomy

Stylidium latrodectus R.L.Barrett, M.D.Barrett & Lowrie, *sp. nov.*

Type: Drysdale River National Park, Western Australia [precise locality withheld for conservation reasons], 29 April 2008, *R.L. Barrett & M.D. Barrett* RLB 4862 (*holo*: PERTH 08615969; *iso*: DNA, MEL).

Stylidium longicornu auct. non Carlquist: J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.,* p. 881, Figure 270e (1992).

A slender, fibrous-rooted annual *herb* 8–34 cm high with translucent white stems, 1–4 mm long. Glandular *hairs* 0.15–0.2 mm long; glands globose, red. *Leaves* 9–16 per plant, arranged in a flat basal rosette, sessile, obovate to spathulate, 2–10 mm long, 1–5 mm wide, flat in section, glabrous; apex obtuse to subacute; base broadly attenuate; margin flat. *Scapes* 1(–3) per plant, 8–34 cm long, 0.7–1.1 mm wide, sparsely to densely glandular-hairy; sterile bracts absent. *Inflorescence* determinate, branches monochasially or dichasially cymose or with flowers solitary, sparsely glandular-hairy; bracts and bracteoles ovate to cordate, 1–2 mm long, 0.5–1.0 mm wide, glandular-hairy; apex acute; pedicels 5–25 mm long, glandular-hairy. *Hypanthium* globose, 1–2.5 mm long, 2–3 mm diam., glandular-hairy. *Sepals* free, narrowly oblong to narrowly elliptic, 2–3 mm long, glandular-hairy, apex obtuse, anterior pair horizontal and splayed outwards under the anterior corolla lobes; middle pair erect; posterior sepal horizontal. *Corolla* tube 1–1.5 mm long, with a pink *nectary spur* 2–5 mm long and cradled by posterior sepal; throat pink or white; lobes entirely dark pink to red on face or broadly dark red around the central veins with narrow, pale margins, dark pink to red on reverse, sometimes with darker pink veins, vertically-paired, glabrous; anterior (lower) lobes irregularly obovate, 3–4.5 mm long, 1.3–2.5 mm wide, apex emarginate; posterior (upper) lobes obovate, 1.1–2.5 mm long, 1.5–2.0 mm wide, apex obtuse and irregularly crenate. *Paracorolla* appendages very small. *Labellum* positioned below the sinus of the anterior corolla lobes, cream, concave, obovate, *c.* 1.5 mm long, *c.* 1 mm wide, glabrous, apex irregularly serrate. *Column c.* 2 mm long (the erect, non-sensitive basal portion *c.* 0.5 mm long, the sensitive cunabulum *c.* 1.5 mm long), without appendages, striking from below; corona absent; stigma stipitate between the anthers, *c.* 1 mm long, apex brush-like; anthers *c.* 0.5 mm long. *Capsule* globose, 2–2.5 mm diam. *Seeds* pale brown, ± compressed-ovoid, 0.17–0.21 mm long, 0.12–0.15 mm diam., finely sculptured. (Figures 1, 2A)

Diagnostic characters. *Leaves* small, basal. *Flowers* with a nectary spur, face of corolla pink, reverse dark pink to red. *Paracorolla* appendages very small. *Column* without appendages. *Hypanthium* globose.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 29 June 2003, *M.D. Barrett & L.W. Sweedman* MDB 1478 (PERTH); 1 June 1993, *D. Dureau* 130

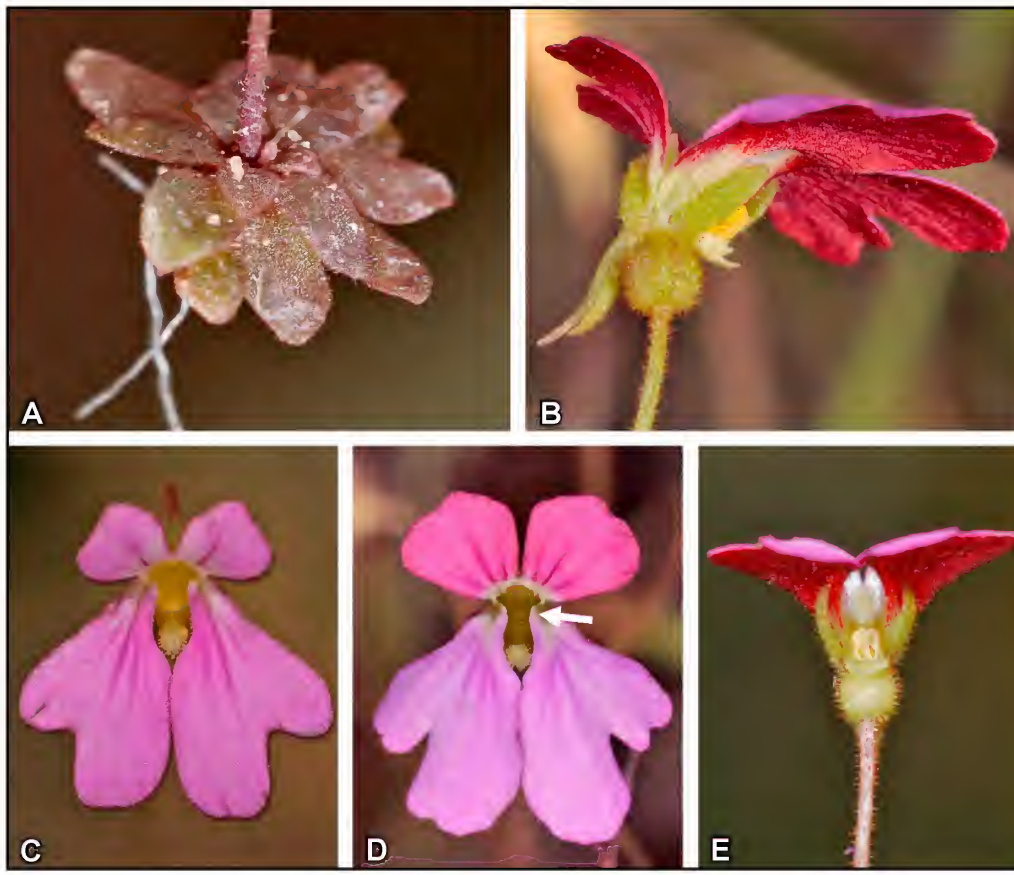

Figure 1. *Stylidium latrodectus*. A – leaf rosette; B – lateral view of flower showing red back to corolla, reflexed sepal, corolla spur and lobed labellum; C – uniformly pink flower; D – bicoloured flower - note constriction near sinus on anterior (lower) corolla lobes, indicated by arrow; E – front of flower from below showing column and labellum. Images from Theda Station (not vouchered; A, C) and *R.L. Barrett & M.D. Barrett* RLB 4862 (B, D, E). Photographs by M.D. Barrett (A, C); R.L. Barrett (B, D, E).

(AD *n.v.*, PERTH); 16 Aug. 1975, *A.S. George* 13914 (CANB, PERTH); 6 Aug. 1975, *K.F. Kenneally* 4012 (PERTH); 6 Aug. 1975, *K.F. Kenneally* 4030 (CANB, K *n.v.*, PERTH); 24 June 1993, *A. Lowrie* 765 (PERTH); 25 June 1993, *A. Lowrie* 776 (PERTH).

Phenology. Flowering and fruiting recorded from April to August.

Distribution and habitat. Recorded between Beverley Springs [Charnley River] Station, the Mitchell Plateau and Drysdale River National Park in Western Australia. Grows on damp sand, usually on sandstone, on sand flats or beside creeks in herbfields.

Conservation status. *Stylidium latrodectus* is to be listed as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.).

Etymology. The epithet is from the genus *Latrodectus* Walckenaer (Araneae; Theridiidae), containing the redback spider, in reference to the dark pink to red back of the corolla that readily distinguishes this species from its nearest relative, *S. longicornu* Carlquist. The epithet is formed as a noun in apposition.

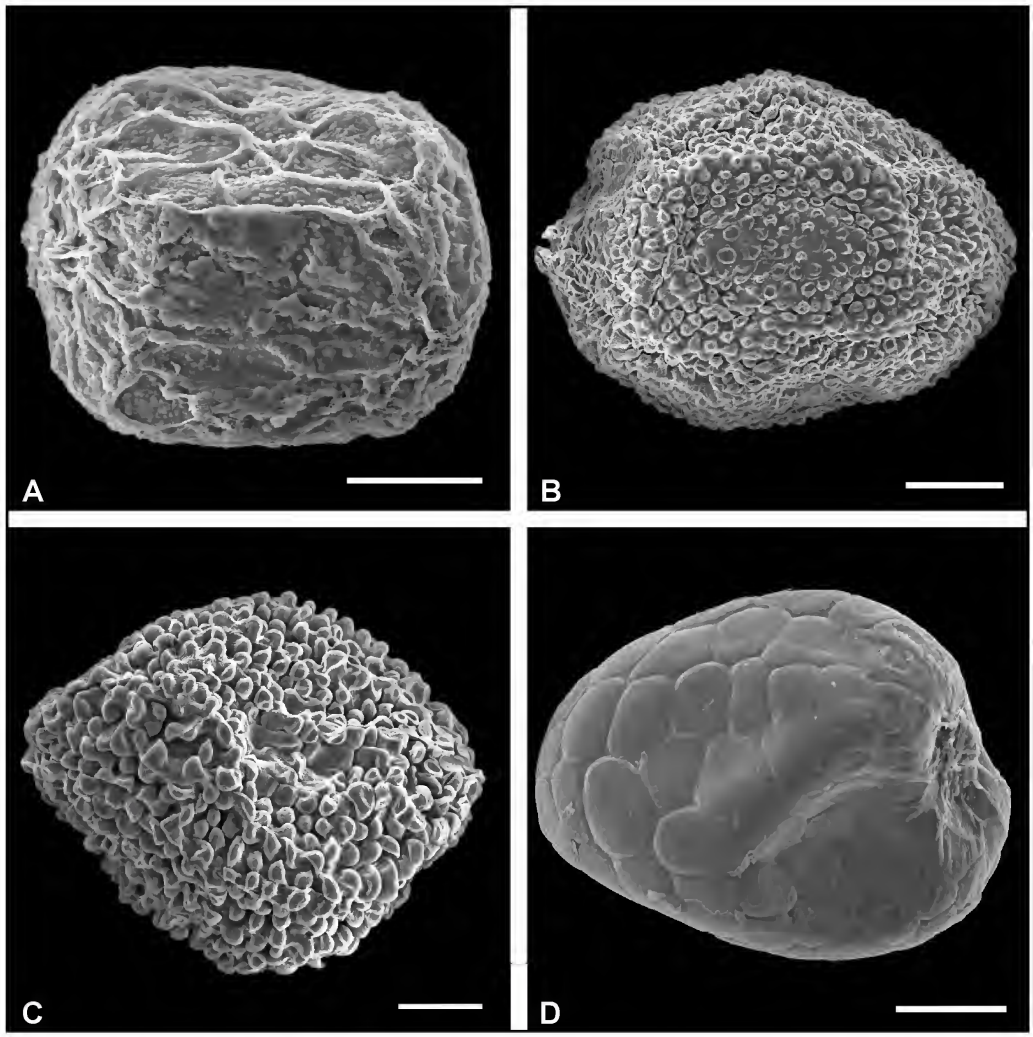

Figure 2. SEM images of *Stylidium* seeds. A – *S. latrodectus*; B – *S. pindanicum*; C – *S. saintpaulioides*; D – *S. willingii*. Images from *D. Dureau* 130 (A), *R.L. Barrett & M. Henson* RLB 7072 (B), *M.D. Barrett & R.L. Barrett* MDB 2917 (C) and *F. Lullfitz* 6052 (D). Scale bars = 50 μm. Images by R.L. Barrett (A, B, D); M.D. Barrett (C).

Notes. *Stylidium latrodectus* has a close affinity with *S. longicornu* and *S. diceratum* Lowrie & Kenneally, the latter occurring within the range of *S. latrodectus*. These three taxa have not been found intermixed at any sites, but are known from similar habitats. *Stylidium latrodectus* is easily distinguished from *S. longicornu* by the red-backed corolla. The flowers of *S. longicornu* have a subtly different corolla shape (the secondary lobing being broader and more rounded on *S. latrodectus*). Carlquist (1979) states in his description of *S. longicornu* 'throat without appendages' and examination of herbarium material and field studies confirm this. *Stylidium latrodectus* usually has very reduced paracorolla lobes that are evident as small ridges or projections near the base of the posterior lobes. It also has a lobe-like structure formed at the sinus on the anterior corolla lobes that increases the constriction of the anterior lobes around the throat, presumably serving to guide pollinators. *Stylidium diceratum* tends to have a longer nectary spur (4.5–6.5 mm and much longer than the corolla *vs* 2–5 mm and much shorter than the corolla in *S. latrodectus*), has two horn-like appendages on the side of the column, and an orange corolla face.

The Western Australian collections previously assigned to *S. longicornu* belong to *S. latrodectus*. *Stylidium longicornu* is known from the Arnhem Land Plateau in the Northern Territory, extending south-east to far north-west Queensland. Prior to the description of *S. longicornu*, specimens of *S. diceratum*, *S. latrodectus* and *S. longicornu* were assigned to *S. ceratophorum* O.Schwarz due to the presence of a nectary spur (e.g. George & Kenneally 1975, 1977).

The dark colouration on the reverse of the corolla on this and other species appears to be a factor influencing flower temperature; the flowers of many tropical *Stylidium* species close overnight, opening, and with the column becoming sensitive, only when there is sufficient light and heat available (RLB, pers. obs.). The dark colouration appears to promote more rapid warming of the flowers in the morning relative to co-occurring species with pale corollas and hence flowers are more likely to be receptive to pollination at the time of peak pollinator activity (usually around 10 am; RLB & AL, pers. obs.).

The vernacular name of Red-backed Triggerplant is recommended.

Stylidium latrodectus can be included in the key of Lowrie and Kenneally (1998) by modifying and adding the following couplets:

9. Plants mostly 5–9 cm tall; posterior corolla lobes cuneate, apex tridentate; nectary spur shorter than the posterior sepal ..... **S. aceratum**

9: Plants mostly 10–25 cm tall; posterior corolla lobes obovate, apex crenate or entire; nectary spur longer than the posterior sepal **10**

10. Reverse of corolla dark pink to red; anterior corolla lobes with a constriction at the sinus; small paracorolla lobes present, sometimes reduced ..... **S. latrodectus**

10: Reverse of corolla white or pale pink; anterior corolla lobes without a constriction at the sinus; paracorolla lobes absent ..... **S. longicornu**

Stylidium pindanicum R.L.Barrett, *sp. nov.*

Type: Cape Leveque Road, Dampier Peninsula, north-east of Broome, Western Australia [precise locality withheld for conservation reasons], 4 May 2011, *R.L. Barrett & M. Henson* RLB 7072 (*holo*: PERTH 08613478; *iso*: AD, BRI, CANB, DNA, K, MEL, NSW).

Illustration. K.F. Kenneally, D. Choules Edinger & T. Willing, *Broome and Beyond*, p. 191 (1996), as *S. leptorrhizum*.

Herbaceous *annual*, 12–32 cm high, with non- or 1-branched stems 13–30 mm long, base not thickened. Glandular *hairs* 0.2–0.3 mm long; glands ellipsoid, red. *Leaves* numerous, 14–49 per rosette, mostly arranged in a terminal rosette with some scattered below along stems to near ground level, with petioles 5–16(–22) mm long; lamina oblanceolate, spathulate or occasionally elliptic with an attenuate base, 7–18 mm long, 2–8 mm wide, flat to canaliculate in section, sparsely glandular-hairy; apex acute to attenuate; base long-attenuate, grading into petiole; margin entire. *Scapes* 1–15 per plant, 7–33 cm long, 0.3–1.6 mm in diam., sparsely glandular-hairy; sterile bracts absent or occasionally 1, 2–2.5 mm long, 0.3 mm wide. *Inflorescences* determinate, monochasially or dichasially cymose, branches sparsely glandular-hairy; bracts linear or lanceolate, 1–4 mm long, glandular-hairy, apex acute; bracteoles absent; pedicels 5–12 mm long, glandular-hairy. *Hypanthium* obovoid to ellipsoid, 1.6–1.9 mm long, 0.5–0.6 mm wide, glandular-hairy. *Sepals* free, obovate to broadly oblong, 0.7–0.9 mm long, 0.4–0.6 mm wide, glandular-hairy, apex obtuse or acutely shortly notched at apex.

Corolla tube 1.4–2.0 mm long, with sinus on anterior side only, glandular-hairy at apex; *lobes* pink or mauve on face or anterior lobes almost white, pink with dark red mottling on reverse, vertically paired, glandular-hairy on reverse; anterior (upper) lobes 1.5–2.0 mm long, 1.1–1.7 mm wide, entire, apex obtuse; posterior (lower) lobes fused for half their length, 2.2–3.5 mm long, 1.1–1.8 mm wide, entire, apex obtuse. *Paracorolla* continuous, lobed, thin, glabrous, *c.* 0.1 or *c.* 0.4 mm high, lobes or appendages 4, dimorphic; central pair at the base of the anterior lobes *c.* 0.1 mm high, white, obtuse; 2 lobes at the base of the posterior lobes *c.* 0.4 mm high, white at base, pink above, flattened, broader at apex and deeply or unevenly notched, apices acute; glands absent. *Labellum* attached to outside of corolla tube at base of anterior sinus, waxy cream, ovate, 0.3–0.4 mm long, 0.15–0.2 mm wide, thick, obtuse or acute, glabrous, with a short terminal appendage to 0.05 mm long. *Column* 4.2–7 mm long, mostly of uniform width, a few glandular hairs towards the apex, cunabulum slightly broader with 2 distinct rows of thick, eglandular hairs on the sides, lateral lobes absent; corona absent; stigma sessile, entire; anthers *c.* 0.6 mm long; pollen tetracolpate, *c.* 30 µm long. *Capsule* ellipsoid, 3.5–4.5 mm long excluding sepals, 1.8–2.3 mm wide, without raised longitudinal ribs; halves detaching distally, not recurved. *Seeds* brown, globose or ellipsoid, 0.2–0.3 mm long, 0.2–0.25 mm diam., prominently and densely colliculate. (Figures 2B, 3, 4B)

Diagnostic characters. *Leaves* slender, numerous, 14–49 held in a terminal rosette with a small number of leaves scattered on the stem below to near ground level, petioles 5–16(–22) mm long; blade 7–18 mm long, 2–8 mm wide. *Inflorescence* paniculate. *Paracorolla* with 4 dimorphic lobes or appendages, 2 central lobes *c.* 0.1 mm high, obtuse, white, 2 lateral lobes *c.* 0.4 mm high, white at base, pink above, flattened, broader at apex and deeply or unevenly notched, apices acute.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 7 May 2011, *R.L. Barrett* RLB 7082 (BM *n.v.*, PERTH); 23 Sep. 1989, *B.J. Carter* 427 (PERTH); 5 May 1991, *B.J. Carter* 459 (DNA *n.v.*, PERTH); 29 Aug. 1993, *B.J. Carter* 667 (PERTH); 3 July 2001, *K. Coate* 640 (PERTH); 20 Aug. 1976, *K.F. Kenneally* 5777 (CANB, PERTH); 19 June 1984, *K.F. Kenneally* 9060 (DNA *n.v.*, PERTH); 22 Aug. 1985, *K.F. Kenneally* 9469 (PERTH); 29 June 1993, *K.F. Kenneally* 11378 (PERTH); 29 June 1993, *K.F. Kenneally* 11381 (DNA *n.v.*, PERTH); 29 June 1993, *K.F. Kenneally* 11387 (PERTH); 27 May 1993, *A.A. Mitchell* 3126 (PERTH); May 1967, *Y. Power s.n.* (PERTH); 11 June 2006, *L.S.J. Sweedman* 6843 (KPBG, PERTH).

Phenology. Flowering and fruiting recorded from May to August.

Distribution and habitat. Restricted to seasonally damp areas over pindan sands on the Dampier Peninsula, east to near Fitzroy Crossing, growing with *Chrysopogon fallax*, *Cleome tetrandra s.l.*, *Eucalyptus tectifica*, *Mitrasacme* spp. and *Sorghum plumosum*.

Conservation status. *Stylidium pindanicum* is to be listed as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.).

Etymology. The epithet refers to the pindan sandplains of the Dampier Botanical District where this species is found.

Notes. This species was illustrated in *Broome and beyond* (Kenneally *et al.* 1996) as *S. leptorrhizum* F.Muell., the application of which was at that stage confused with *S. semipartitum* F.Muell. *Stylidium pindanicum* is related to both of these species, differing in the position of the leafy rosette (terminal, but on average the stem is much shorter than in *S. semipartitum*, so the rosette is held close to the

Figure 3. *Stylidium pindanicum*. A – habitat at type locality; B – habit; C – sparsely hairy leaves; D – leafy rosette showing leaves spread along the stem; E – flower with reflexed column showing marginal hairs on cunabulum, glossy labellum on corolla tube and red flecks on reverse of corolla; F, G – corolla face with small, white, central paracorolla lobes and pink, spreading, lateral paracorolla lobes - note red, thickened margin to the cunabulum. Images from *R.L. Barrett & M. Henson* RLB 7072. Photographs by R.L. Barrett.

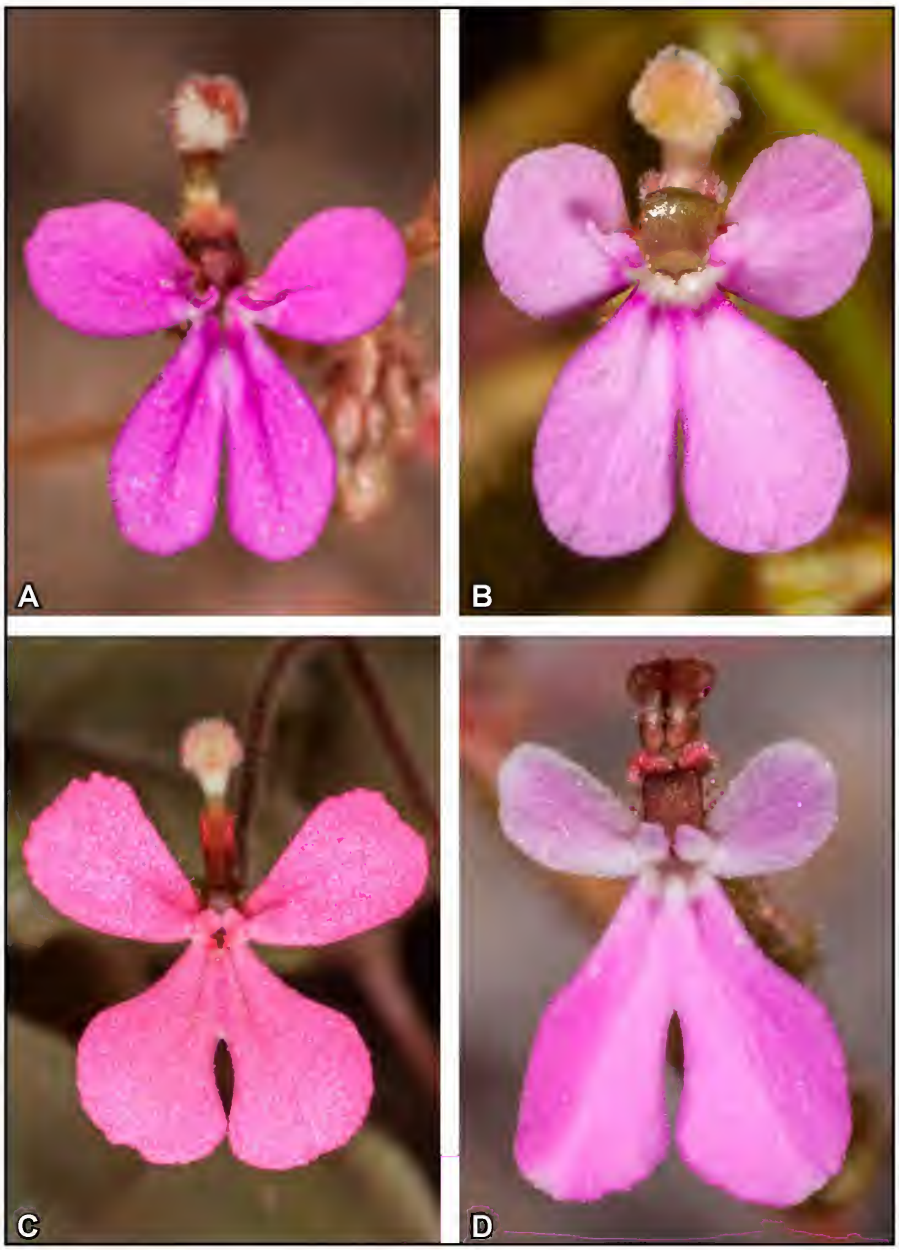

Figure 4. Comparative images of the corolla face of species in the *Stylidium leptorrhizum* group. A – *S. leptorrhizum*; B – *S. pindanicum*; C – *S. saintpaulioides*; D – *S. semipartitum*. Images from *R.L. Barrett* RLB 7362 (A), *R.L. Barrett & M. Henson* RLB 7072 (B), *M.D. Barrett & R.L. Barrett* MDB 2917 (C) and Phillips Range (not vouchered; D). Photographs by R.L. Barrett.

ground), slender leaves that are more sparsely hairy and the arrangement of the paracorolla. These taxa can be separated using leaf characteristics visible on herbarium specimens. *Stylidium saintpaulioides*, described below, is also part of this species group and the key features distinguishing these four species are presented in Table 1.

The application of the name *S. semipartitum* has been confused for most of its history, having been included under *S. leptorrhizum* by Bentham (1868). Bean (1999) correctly assigned the two names, but did not examine the type of *S. semipartitum* which was on loan to PERTH at the time of his studies, basing his conclusions on the description in Mueller (1859). The type of *S. semipartitum* is a collection by F. Mueller from the Victoria River, Northern Territory (K 000741766). The two plants on the type sheet have distinct, compact rosettes of 10–20 leaves concentrated at the stem apex. The leaves have long, distinct petioles and narrowly ovate to ovate laminas with more or less obtuse apices. The inflorescences of *S. semipartitum* are few-branched and have a sparse appearance. These features contrast strongly with the slender, acute to attenuate leaves and more-branched, denser inflorescences of *S. pindanicum*.

The vernacular name of Pindan Triggerplant is recommended.

Table 1. Key distinguishing features for *Stylidium leptorrhizum*, *S. pindanicum*, *S. saintpaulioides* and *S. semipartitum*.

	S. leptorrhizum	*S. pindanicum*	*S. saintpaulioides*	*S. semipartitum*
Stem length	2–6 mm	13–30 mm	35–160 mm	(16–)23–64 mm
Leaf arrangement	Basal	Terminal, and cauline, density reduced below	Terminal, a few leaves scattered below	Terminal, a few leaves scattered below
Leaf shape	Oblanceolate or elliptic, base cuneate	Oblanceolate, spathulate or occasionally elliptic, base attenuate	Broadly obovate, base usually deeply cordate	Oblanceolate, elliptic or obovate, base obtuse or cuneate
Leaf indumentum	Glabrous	Sparsely glandular-hairy	Sparsely glandular-hairy (sometimes glabrous on blade)	Sparsely glandular-hairy
Petiole length	3–13 mm	5–16(–22) mm	12–56 mm	5–20(–28) mm
Corolla colour	Dark pink or mauve on face; pink, mottled dark red on reverse	Pink or mauve on face or anterior lobes almost white; pink, mottled dark red on reverse	Orange-pink on face; pale orange-pink on reverse	Pink to dark pink on face, anterior lobes sometimes white; white to pale pink on reverse
Corolla tube length	3–3.5 mm	1.4–2 mm	3.4–3.9 mm	2.2–2.7 mm
Anterior corolla lobes	2.8–4 × 1.8–2.5 mm, obtuse	1.5–2 × 1.1–1.7 mm, obtuse	2.7–3.7 × 1.2–1.3 mm, obtuse	1.5–3.5 × 0.6–1.9 mm, acute or obtuse
Posterior corolla lobes	3.2–5 × 1.2–3 mm	2.2–3.5 × 1.1–1.8 mm	3.5–5.3 × 1.5–1.8 mm	2.5–4.2 × 1.5–2.8 mm
Paracorolla appendages	2, both similar, acute or obtuse	4, dimorphic, acute or obtuse	4, dimorphic, acute or obtuse	2 or 4, dimorphic, acute or obtuse

The key provided by Bean (1999) can be adapted to include *S. pindanicum* and *S. saintpaulioides* by modifying and adding the following couplets:

17. Leaves glandular-hairy (at least on margins) **17A**

17: Leaves glabrous **18**

17A. Leaf bases usually distinctly cordate; corolla face orange-pink ..... **S. saintpaulioides**

17A: Leaf bases acute to cuneate, not cordate; corolla face pale to dark pink **17B**

17B. Stem 13–30 mm, rosette terminal but held close to the ground; leaf blade 7–18 mm long, 2–8 mm wide, apex acute to attenuate ..... **S. pindanicum**

17B: Stem (16–)23–64 mm, rosette terminal and held well clear of the ground; leaf blade 6–30 mm long, 3–21 mm wide, apex obtuse to acute ..... **S. semipartitum**

Stylidium saintpaulioides R.L.Barrett, M.D.Barrett & Lowrie, *sp. nov.*

Type: Lawley River National Park, Western Australia [precise locality withheld for conservation reasons], 29 March 2010, *M.D. Barrett & R.L. Barrett* MDB 2917 (*holo*: PERTH 08615217; *iso*: BRI, CANB, DNA, K, MEL).

Herbaceous *annual*, 11–40 cm high, with *stems* 35–160 mm long, base not thickened, sparsely glandular-hairy. Glandular *hairs* 0.3–0.5 mm long; glands ellipsoid, red. *Leaves* 10–16 per plant, mostly arranged in a terminal rosette with a few scattered along the stem, with petioles 12–56 mm long; lamina broadly obovate, 11–52 mm long, 8–34 mm wide, flat to shallowly convex in section, sparsely glandular-hairy or glabrous; apex obtuse; base usually deeply cordate, sometimes subcordate to attenuate in younger leaves; margin entire, sparsely glandular-hairy. *Scapes* 1–9 per plant, 5–22 cm long, 0.3–0.7 mm diam., sparsely glandular-hairy; sterile bracts absent. *Inflorescence* determinate; monochasially or dichasially cymose, branches glandular-hairy; bracts lanceolate, 1–2 mm long, glandular-hairy, apex acute; bracteoles absent; pedicels 14–25 mm long, glandular-hairy. *Hypanthium* ellipsoid, 2.9–4.6 mm long, 0.9–1.2 mm wide, glandular-hairy. *Sepals* free, deltate to ovate, 1.4–1.7 mm long, 0.5–0.7 mm wide, glandular-hairy, apex acute. *Corolla* tube 3.4–3.9 mm long, with sinus on anterior side only, glandular-hairy; lobes orange-pink on face, pale orange-pink on reverse, vertically paired, glandular-hairy; anterior (upper) lobes 2.7–3.7 mm long, 1.2–1.3 mm wide, entire, apex obtuse; posterior (lower) lobes fused for *c.* 1/3 their length, 3.5–5.3 mm long, 1.5–1.8 mm wide, entire, apex obtuse. *Paracorolla* discontinuous, lobed, thin, glabrous, *c.* 0.1 or 0.4 mm high, lobes or appendages 4, dimorphic; 2 at the base of the anterior lobes *c.* 0.4 mm high, pink to white, acute; 2 at the base of the posterior lobes *c.* 0.1 mm high, pink to white, obtuse; glands absent. *Labellum* attached to the outside of the corolla tube on the anterior sinus, ovate, reddish brown, 0.5–0.6 mm long, 0.2–0.3 mm wide, thick, obtuse, glabrous, terminal appendage absent. *Column* 6.0–7.1 mm long, of uniform width with 2 rows of squat glandular hairs on the cunabulum, without lateral lobes; corona absent; stigma sessile, entire; anthers *c.* 0.2 mm long. *Capsule* ellipsoid, 4.4–6.6 mm long excluding sepals, 1.6–2.9 mm wide, without raised longitudinal ribs; halves detaching distally, not recurved. *Seeds* reddish brown, globose or ellipsoid, 0.32–0.38 mm long, 0.30–0.36 mm wide, finely and densely colliculate. (Figures 2C, 4C, 5)

Diagnostic characters. *Leaf* bases usually deeply cordate. *Petioles* 12–56 mm long. *Corolla* tube 3.4–3.9 mm long. Anterior *corolla lobes* 2.7–3.7 mm long, 1.2–1.3 mm wide, entire, obtuse. Posterior *corolla lobes* 3.5–5.3 mm long, 1.5–1.8 mm wide.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 1 May 1985, *T.E.H. Aplin, R.J. Cranfield, B.L. Rye & J.R. Wheeler* 857 (PERTH); 12 Mar. 2014,

Figure 5. *Stylidium saintpaulioides*. A – habit under sandstone overhang with many open flowers; B – leaves with cordate bases; C – inflorescence showing reduced branching structure (relative to *S. semipartitum*) and many simultaneously open flowers; D – lateral view of flower showing calyx, labellum and orange-pink reverse of corolla lobes; E – oblique view of flower with reflexed column showing erect paracorolla lobes; F – flower with small, visiting fly - note prominent paracorolla lobes. Images from *M.D. Barrett & R.L. Barrett* MDB 2917. Photographs by R.L. Barrett.

R.L. Barrett RLB 8966 (PERTH); 29 Apr. 2008, *R.L. Barrett & M.D. Barrett* RLB 4862 (PERTH); 29 Apr. 2008, *R.L. Barrett & M.D. Barrett* RLB 4864 (PERTH); 29 Apr. 2008, *R.L. Barrett & M.D. Barrett* RLB 4906 (PERTH); 12 Mar. 2014, *G. Bourke per R.L. Barrett* RLB 9001 (PERTH); 14 May 1983, *P.A. Fryxell & L.A. Craven* 4129 (CANB, PERTH); 20 Aug. 1975, *A.S. George* 14087 (CANB, K, PERTH); 7 Mar. 1989, *G.J. Keighery* 10797 (PERTH); 26 June 1973, *P.G. Wilson* 10971 (PERTH).

Phenology. Flowering and fruiting from March to June (rarely August).

Distribution and habitat. Only known from a small area in the far-north Kimberley, from Theda Station and Drysdale River National Park north to Lawley River National Park. This species is restricted to rock overhangs where it commonly grows with *Micraira dunlopii*, *Mitrasacme graminea* and *M. scrithicola*.

Conservation status. *Stylidium saintpaulioides* is to be listed as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.).

Etymology. The epithet refers to the genus *Saintpaulia* H.Wendl. (Gesneriaceae) to which this species bears a significant resemblance due to the rosette of broad, dark leaves and display of orange-pink flowers.

Notes. *Stylidium saintpaulioides* is a distinctive species that is probably most closely related to *S. semipartitum*, differing most obviously in having large leaves with cordate bases. It is also related to *S. leptorrhizum* and *S. pindanicum*. The differences between all these species are detailed in the key above, in Table 1 and in Figure 4.

The vernacular name of Saintpaulia Triggerplant is recommended.

Stylidium willingii R.L.Barrett, Kenneally & Lowrie, *sp. nov.*

Type: Sandstone pavement on west side of King Edward River, west-north-west of Theda Station Homestead, Western Australia, 12 March 2014, *R.L. Barrett* RLB 8960 (*holo*: PERTH 08613451; *iso*: BRI, CANB, DNA).

Herbaceous *annual*, 8–44 cm high, with *stems* contracted or to 5 cm long, base not thickened. Glandular *hairs* 0.05–0.1 mm long; glands globose, red to reddish black. *Leaves* 5–9 per plant, arranged in a flat basal rosette or a few scattered on the stem, sessile or with petioles up to 5.5 mm long, obovate, 7–26(–40) mm long excluding petiole, 5–16 mm wide, flat in section, glabrous; apex obtuse; base obtuse to cuneate; margin entire. *Scapes* 1–4 per plant, 8–47 cm long, 0.5–0.7 mm in diam., sparsely glandular-hairy; sterile bracts absent. *Inflorescences* determinate, branches monochasially cymose, glandular-hairy; bracts linear or lanceolate, 0.9–2.1 mm long, glandular-hairy, apex acute; bracteoles absent; pedicels absent. *Hypanthium* linear, (3–)9–12 mm long, 0.3–0.4 mm wide, glandular-hairy throughout. *Sepals* with 3 free and 2 fused to the apex, linear to oblanceolate, 1.4–1.5 mm long, 0.25–0.50 mm wide, glandular-hairy, apex obtuse. *Corolla* tube 1.7–1.9 mm long, with sinus on anterior side only, glandular-hairy; *lobes* all free to the tube, pale pink on face, cream with red veins on reverse, vertically paired, glabrous; anterior (upper) lobes 1.0–1.1 mm long, 0.5–0.6 mm wide, entire, apex obtuse; posterior (lower) lobes 1.6–2.0 mm long, 1.2–1.4 mm wide, apex obtuse and slightly notched. *Paracorolla* continuous, thin, glabrous, 0.1 or 0.2 mm high, with 6 lobes; 4 lobes at the base of the posterior lobes small, yellow, obtuse or acute; 2 lobes at the base of the anterior lobes larger, yellow and reddish pink; glands absent. *Labellum* attached to outside of corolla tube below sinus, off-white,

ovate or lanceolate, 0.5–0.6 mm long, 0.2–0.3 mm wide, thick, acuminate, glabrous with terminal appendage to 0.05 mm long. *Column* 4.5–6.9 mm long, mostly of uniform width, glabrous; with lateral lobes *c.* 0.4 mm wide, forming slender wings on the cunabulum; corona absent; stigma sessile, entire; anthers *c.* 0.6 mm long. *Capsule* linear, 9–12 mm long excluding sepals, 0.3–0.5 mm wide, without raised longitudinal ribs; halves detaching distally, sometimes recurved. *Seeds* reddish brown, ellipsoid to bullet-shaped, 0.16–0.24 mm long, 0.14–0.20 mm wide, finely sculptured. (Figures 4D, 6)

Diagnostic characters. *Corolla* face pale pink, reverse cream with red veins; ring of six paracorolla lobes around the throat. *Corolla lobes* vertically paired, all free to the top of the tube. *Column* 4.5–6.9 mm long; lateral lobes present, *c.* 0.4 mm wide, forming slender wings on the cunabulum.

Other specimens examined. WESTERN AUSTRALIA: Wren Gorge, Edkins Range, 7 July 1993, *M.D. Barrett & R.L. Barrett* MDB 249 (PERTH); Edkins Range, near Drosera Gully, on sand flats north of jump-up, N of Charnley River Crossing, 62 km N of Beverley Springs Station Homestead, 9 July 1994, *R.L. Barrett & M.D. Barrett* RLB 8817 (PERTH); Wren Gorge, Edkins Range, 11 July 1994, *R.L. Barrett & M.D. Barrett* RLB 8820 (PERTH); 3 km W of Kalumburu, 24 May 1993, *I. Cowie* 4263 *& C. Brubaker* (CANB, DNA *n.v.*, PERTH); King Edward River Crossing, 5 June

Figure 6. *Stylidium willingii*. A – habitat at type locality; B – leafy rosette; C – flower with reflexed column showing small wings on cunabulum, distinct, yellow paracorolla rim and red, lateral paracorolla lobes; D – inflorescence. Images from *R.L. Barrett* RLB 8960. Photographs by R.L. Barrett.

1987, *D.J. Edinger* 276 A (PERTH); King Edward River Crossing, 12 June 1987, *D.J. Edinger* 362 (PERTH); unnamed creek running into Pauline Bay, *c.* 1 km upstream from tidal influence, 25 May 1984, *S.J. Forbes* 2155 (MEL, PERTH); Blyxa Creek, Prince Regent River Reserve, 19 Aug. 1974, *A.S. George* 12428 (CANB, PERTH); King Edward River Crossing, 10 June 1987, *G.J. Keighery* 9543 (PERTH); King Edward River Crossing, 24 June 1993, *A. Lowrie* 768 (PERTH); Kalumburu, Sep. 1968, *F. Lullfitz* 6052 (PERTH); Morgan River, near old Theda Homestead, 28 July 1977, *I.R. Telford* 6204 (CANB, PERTH).

Phenology. Flowering and fruiting recorded from March to August.

Distribution and habitat. Known from the North Kimberley, from the Edkins Range north to the King Edward River and Kalumburu. Grows in damp sandy areas, often in creeks and gorges on sandstone. This species grows among thick grasses and herbs that often obscure its presence, with just the flowers showing at the top of the grass layer.

Conservation status. *Stylidium willingii* is reasonably widespread in the Kimberley and is not currently considered to be threatened.

Etymology. This species is named in honour of Tim Willing, a long-time resident of Broome, in recognition of his outstanding contribution to the understanding of the Kimberley flora through his formidable collecting efforts, his encyclopaedic knowledge of tropical horticulture and his collaborative approach to sharing botanical knowledge.

Notes. *Stylidium willingii* appears to have affinities with *S. lobuliflorum* F.Muell., *S. pachyrrhizum* F.Muell. and *S. schizanthum* F.Muell. It resembles all of these species in having a small, basal leaf rosette and small throat appendages (the upper two being bright pink-red), but it lacks a true paracorolla gland. It may also have affinities with *S. accedens* A.R.Bean which looks superficially similar and sometimes has six small throat appendages, but has distinctly notched anterior corolla lobes. *Stylidium willingii* is readily distinguished from all of these species by its posterior corolla lobes, which are free to the tube and not fused at the base, and the presence of wing-like appendages on the cunabulum. This latter feature may ally it to the *S. muscicola* F.Muell. species complex, from which *S. willingii* is readily distinguished by its basal rosette and contracted stem (members of the *S. muscicola* species complex have a terminal rosette on an elongated stem).

The vernacular name of Willing's Triggerplant is recommended.

The key provided by Bean (2000) can be adapted to include *S. willingii* by modifying and adding the following couplets:

22. Petals all free [Al+A2+Pl+P2]..... **22A**

22: Posterior petals fused [Al+A2+(Pl&P2)]..... **24**

22A. Column 4.5–6.9 mm long, lateral lobes present; no sterile bracts on scape..... **S. willingii**

22A: Column 2.5–3.5 mm long, lateral lobes absent; sterile bracts usually present on scape..... **23**

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A new species of *Gomphrena* (Amaranthaceae) from the Bonaparte Archipelago, Western Australia

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Abstract

Barrett, R.L. & Palmer, J. A new species of *Gomphrena* (Amaranthaceae) from the Bonaparte Archipelago, Western Australia. *Nuytsia* 26: 143–147 (2015). *Gomphrena splendida* R.L.Barrett & J.Palmer is described as a new species endemic to islands of the Bonaparte Archipelago in the north-west Kimberley region of Western Australia. This new species has a highly restricted distribution. It is unusual among the Australian species of *Gomphrena* L. in being a large, fleshy, perennial with very large flowers, giving this species significant horticultural potential in tropical areas. A modified key and images are presented.

Introduction

The genus *Gomphrena* L. has been revised for Australia by Palmer (1998) who recognised 33 species in the region. The year this revision was published Andrew Mitchell discovered what appeared to be a distinctive new species on two islands in the Bonaparte Archipelago, off the Kimberley coast in Western Australia, while conducting surveys for the Australian Quarantine Inspection Service. It remained known only from Mitchell's collections until additional populations were found in 2007 and 2008 by the lead author and others during a survey of the Maret Islands and surrounding area for INPEX Operations Australia Ltd (Henson *et al.* 2014). Many collections were made, and all suitable habitats between Bigge and Berthier Islands in the south and Bougainville Peninsula in the north were searched on foot or, in the case of coastal cliffs, from a boat using binoculars.

These surveys found a species that appears to be confined to coastal habitats, rarely occurring more than 200 m from the ocean, and growing on some islets that are near impossible to land on, discounting the notion that the species could be an introduction. Consultation of major Floras and works on *Gomphrena* have failed to identify any similar taxa elsewhere in the world. While the vegetative features of the plant are remarkably distinct, the floral morphology suggests a close affinity to the Australian endemic species *G. flaccida* R.Br. (Palmer 1998). Unique among the Australian species, this new taxon is a perennial with very broad, somewhat fleshy leaves and thickened stems, similar in appearance to the Brazilian species *G. glabratoides* (Suess.) J.C.Siqueira and *G. globosa* L. Plants can grow up to 1.5 m across and carry several hundred inflorescences, giving a very attractive appearance. We conclude

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that this is a distinctive new species, endemic to islands of the Bonaparte Archipelago, and describe it here as *G. splendida* R.L.Barrett & J.Palmer.

Methods

The description was prepared based on herbarium specimens at CANB and PERTH, supplemented with field observations.

Modified key to *Gomphrena* in Australia

The couplets 32–34 of the key provided by Palmer (1998) require modification as follows.

32. Bracts sessile on rachis; outer 3 tepals glabrous or with sparse hairs covering some of length **33**

32: Bracts attached to rachis by a small, hairy stalk up to 3 mm long; outer 3 tepals covered with dense hairs for some or most of length, or glabrous..... **33a**

33. Biennial or short-lived perennial with a basal rosette of leaves; bracts and bracteoles opaque white for 3/4 to almost entire length; bracteole apex straight ..... **4. G. rosula**

33: Annual herb without a basal rosette; bracts and bracteoles translucent throughout or opaque white for up to 1/2 of length; bracteole apex more or less recurved..... **3. G. flaccida**

33a. Large, perennial herb with broad leaves > 7 mm wide; outer 3 tepals glabrous ..... **G. splendida**

33a: Annual herb with narrow leaves < 7 mm wide; outer 3 tepals covered with dense hairs for some or most of length **34**

34. Bracts triangular-ovate, 4.5–9.5 mm long, glabrous (Pilbara and east Kimberley WA, Victoria River area NT)..... **5. G. affinis**

34: Bracts broadly ovate, 1.5–5 mm long, hairy (Gulf of Carpentaria and central Qld)..... **35**

Taxonomy

Gomphrena splendida R.L.Barrett & J.Palmer, *sp. nov.*

Type: North Maret Island, Western Australia, [precise locality withheld for conservation reasons], 28 February 2007, *R.L. Barrett* RLB 9048 (*holo*: PERTH 08615152; *iso*: BRI, CANB, DNA, K, MEL).

Gomphrena sp. Maret Islands (A.A. Mitchell 5414), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Perennial herb with thickened rootstock, basal stems to 12 mm thick, erect to spreading, up to 1 m high and 1.5 m wide, multi-stemmed; stems sparsely appressed-hairy to glabrescent except for a dense tuft of erect hairs in the leaf axils. *Leaves* bright green, slightly discolorous, cauline, sessile or with petiole to 14 mm long; lamina lanceolate to ovate or oblong, 37–156 mm long, 11–47 mm wide; sparse, appressed to spreading, rough hairs above, sparse, spreading to erect, soft hairs below; leaves subtending inflorescence bract-like, ovate to oblong, 8–17 mm long, 6–11 mm wide. *Inflorescence* terminal or rarely axillary, sessile within the uppermost 2–4(–8) leaves or pedunculate; spikes solitary, semi-globose to globose, 26–40 mm long, 30–51 mm wide, not or scarcely elongating. *Floral bracts* lanceolate to narrowly ovate, 8–9 mm long, *c.* 2 mm wide, stalked on a pilose rachis, margin entire, acuminate, lamina glabrous, translucent throughout to opaque white in upper third, except white,

prominent, excurrent midnerve. *Bracteoles* lanceolate to narrowly ovate, 5–8 mm long, 3–3.5 mm wide, distinctly shorter than tepals, margin entire, acuminate to aristate, flat, glabrous, translucent throughout to opaque white in upper third, except white, prominent, excurrent midnerve. *Tepals* narrowly oblong, 9.2–15.5 mm long, 1.6–2.6 mm wide, inner tepals very slightly shorter than outer, margin entire, acute, revolute on drying, glabrous; bright pink, sometimes with a few dark red streaks or pale green towards the base of the midnerve; midnerve terminating as a narrow vein at tepal apex. *Stamens* 5, 6.5–12 mm long; filaments united for 3/4 to 7/8 of length in a tube longer than the fruit, woolly in lower half inside, glabrous above and outside; free portion 1.8–2.4 mm long, margin entire, acute; anthers 2.4–2.8 mm long; pseudostaminodes absent. *Style* 6.7–9.3 mm long; stigma 0.4–0.8 mm long. *Fruit* ovoid, 3.2–3.8 mm long, 1.3–1.9 mm wide. *Seed* compressed-obovoid to compressed-ellipsoid, 2.2–2.4 mm long, 1.3–1.5 mm wide. (Figure 1)

Diagnostic characters. Distinguished from all Australian species by the following combination of characters: perennial *subshrub*; *leaves* broad, 37–156 mm long, 11–47 mm wide; *inflorescence* large, 26–40 mm long, 30–51 mm wide, not elongating; *bracts*, *bracteoles* and *tepals* glabrous; *staminal tube* woolly in lower half inside.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons]: 17 Apr. 2007, *R.L. Barrett & A. Cross* RLB 9046 (PERTH); 27 May 2007, *R.L. Barrett, N. Evelegh, J.J. Alford & S. Walker* RLB 9044 (CANB, PERTH); 27 May 2007, *R.L. Barrett, N. Evelegh, J.J. Alford & S. Walker* RLB 9045 (DNA, PERTH); 19 Apr. 2007, *M. Henson & V. Levien per R.L. Barrett* RLB 9047 (PERTH); 16 May 1998, *A.A. Mitchell* 5414 (CANB, PERTH); 16 May 1998, *A.A. Mitchell* 5421 (CANB, PERTH); 24 Apr. 2007, *R. Orifici & V. Yeomans per R.L. Barrett* RLB 9049 (PERTH); 17 Apr. 2008, *S. Reiffer* SR 14 (PERTH).

Phenology. Some flowering and fruiting apparently occurs year-round, but peaks from February to August.

Distribution and habitat. Known only from a few islands and surrounding islets in the northern part of the Bonaparte Archipelago, off the Kimberley coast in Western Australia. The named islands include Albert, Berthier, North Maret, South Maret, Turbin and West Montalivet Islands (Henson *et al*. 2014). This species grows on shallow beach sands, on lateritic and loam soils over basalt, often on cliffs (Figure 1A–C), and always in very close proximity (< 200 m) to the ocean.

Conservation status. *Gomphrena splendida* was recently listed as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, as *Gomphrena* sp. Maret Islands (A.A. Mitchell 5414) (Western Australian Herbarium 1998–). Extensive searches were undertaken for this species by INPEX Operations Australia Ltd in the northern Bonaparte Archipelago and adjacent mainland and it appears to be restricted to these few islands. Surveys for this species led by the lead author and M. Henson located about 40 localised populations, with about 7,500 mature plants located on six named islands and a number of small, unnamed islets in the Bonaparte Archipelago.

Etymology. The epithet is from the Latin *splendidus* (splendid), in reference to the showy flowers and attractive leaves and habit of this species, which suggest it has great horticultural potential.

Notes. The thick, perennial rootstock and stems of this species is very distinctive (Figure 1D), as are the broad, somewhat fleshy leaves (Figure 1E). *Gomphrena splendida* co-occurs with *G. canescens* (Moq.) Druce subsp. *canescens* and is somewhat similar in appearance due to the large, bright pink

Figure 1. *Gomphrena splendida*. A – flowering plant in coastal grassland on basalt soils on Berthier Island; B – flowering plant on laterite boulders on South Maret Island; C – flowering plant on beach sand on South Maret Island; D – thickened, perennial stems with clustered leaves; E – broad, almost fleshy leaves; F – infructescence; G – view of inflorescence from above, with potential pollinator; H – flowers; I – comparative images of *G. canescens* subsp. *canescens* showing similar inflorescence (top) and narrower leaves (bottom). Photographs by R.L. Barrett.

inflorescence (Figure 1I), but the latter can be distinguished by its annual habit, narrower leaves 1–5(–6) mm wide (*cf.* 11–47 mm wide), hairy tepals (*cf.* glabrous), the presence of pseudostaminodes (cf. absent) and the inside of the staminal tube being glabrous (*cf.* woolly in lower half).

Gomphrena splendida appears to be closely related to *G. flaccida* based on its combination of floral characters, and also grows in close proximity, but this latter species is an annual, has narrower spikes 12–28 mm wide (*cf.* 30–51 mm wide), narrower leaves 1–7(–13) mm wide and glabrous staminal tube.

The Brazilian species *G. glabratoides* and *G. globosa* are superficially similar due to their broad leaves and pink flowers, but differ significantly in floral characteristics and no direct relationship is suggested here.

The very large heads of flowers show horticultural merit (Figure 1B, G). Several plants were grown from cuttings at Kings Park and Botanic Garden in Perth; however, after growing well for a few years they eventually succumbed to frost (D. Growns pers. comm.). The species is likely to make an attractive horticultural plant in frost-free areas.

Gomphrena splendida is commonly visited by butterflies and other potential pollinators that obtain small amounts of nectar from the flowers. The most common visitor is the Fuscous Swallowtail (*Papilio fuscus* subsp. *canopus* Westwood). The Large Grass-yellow (*Eurema hecabe* L.), Northern Pencil-blue (*Candalides gilberti* Waterhouse), White Migrant (*Catopsilia pyranthe* L.) and day-active moths in the family Arctiidae have also been observed visiting the flowers for nectar.

The vernacular name of Splendid Bachelor Buttons is recommended.

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Two new species of *Phyllanthus* from northern Australia and notes on *Phyllanthus*, *Sauropus* and *Synostemon* (Phyllanthaceae) in Western Australia

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Abstract

Barrett, R.L. & Telford, I.R.H. Two new species of *Phyllanthus* from northern Australia and notes on *Phyllanthus*, *Sauropus* and *Synostemon* (Phyllanthaceae) in Western Australia. *Nuytsia* 26: 149–166 (2015). Two new species of *Phyllanthus* L. are described, both included within *P.* subgen. *Lysiandra* F.Muell.; *P. eremicus* R.L.Barrett & I.Telford occurring in the Pilbara, Great Sandy Desert and southern Dampierland bioregions of Western Australia and the Tanami region of the Northern Territory, and *P. hamelinii* I.Telford & R.L.Barrett restricted to the Carnarvon bioregion, Western Australia. Both species have reasonably restricted or poorly known distributions and *P. eremicus* is of some conservation concern. *Sauropus rigidulus* (Müll.Arg.) Airy Shaw is formally recorded for Western Australia and a full description is provided. All of these taxa have previously been listed on Western Australia's plant name census as phrase-named taxa. All three species are described and illustrated. Notes are made on the application of misapplied names and phrase-named taxa in *Phyllanthus*, *Sauropus* Blume and *Synostemon* F.Muell. in use in Western Australia.

Introduction

The identification of plants in Phyllanthaceae in Australia may prove difficult because of their usually small, unisexual flowers, frequent dioecy, lack of modern keys and overly broad species concepts sometimes incorporating polymorphic species assemblages (Telford, unpubl. data). As a result, the list of taxa on *FloraBase* (Western Australian Herbarium 1998–) contains many informal phrase names. To compound the problem, application of generic names is contentious (Kathriarchchi *et al.* 2006; Hoffmann *et al.* 2006; Pruesapan *et al.* 2008, 2012), particularly the generic and infrageneric circumscriptions of *Phyllanthus* L.

Phyllanthus has been demonstrated to be polyphyletic (Kathriarachchi *et al.* 2006), and the recognition of a giant genus of some 1,300 species subsuming *Breynia* J.R.Forst. & G.Forst., *Glochidion* J.R.Forst. & G.Forst. and *Sauropus* Blume (then including *Synostemon* F.Muell.) has been proposed by Hoffmann *et al.* (2006). An alternative view splitting *Phyllanthus* into smaller genera, with the major clades

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retrieved in Kathriarachchi *et al.* (2006) treated at generic rather than subgeneric rank, has been presented (Pruesapan *et al.* 2008, 2012; van Welzen *et al.* 2014), and is a view that we favour. While a broad concept of *Phyllanthus* is adopted here for practicality, future research will undoubtedly lead to some taxonomic modification.

We here name two new species from *Phyllanthus* subgen. *Lysiandra* F.Muell. that have previously been known by informal phrase names and aim to clarify the application of names, including other informal phrase names, in *Phyllanthus* and *Sauropus* in use on *FloraBase* (Western Australian Herbarium 1998–). This will enable most currently listed phrase names to be removed from Western Australia's plant census. The genus *Synostemon* is recognised by us, but most taxa belonging in this genus still await formal combinations and are listed under their current names. Some taxa have recently been transferred by van Welzen *et al.* (2014) and papers making the remainder of Australian combinations are in preparation (Telford *et al.*, in prep.).

Phyllanthus eremicus R.L.Barrett & I.Telford has conservation priority as it is known from only a few, but widespread, collections in the Pilbara, Great Sandy Desert and southern Dampierland bioregions of Western Australia and three collections from central Northern Territory. *Phyllanthus eremicus* has been included in a broad concept of *P. aridus* Benth. in the past, but field studies by the first author have shown these taxa to be distinct. *Phyllanthus hamelinii* I.Telford & R.L.Barrett occurs almost exclusively in coastal areas of the Carnarvon bioregion, but also occurs on offshore islands in the Pilbara bioregion. It has previously been confused with *P. fuernrohrii* F.Muell. from central and eastern Australia. *Phyllanthus fuernrohrii* is noted to also occur in Western Australia, near the border with South Australia.

The name *P. reticulatus* Poir. has been misapplied in Western Australia, where all specimens are correctly placed in *P. baccatus* F.Muell. ex Benth. *Phyllanthus* sp. D Kimberley Flora (C.R. Dunlop 5302) is a current name on *FloraBase* (Western Australian Herbarium 1998–); it is here formally listed as a synonym of *P. indigoferoides* Benth., a name not applied by Wheeler (1992).

Phyllanthus minutiflorus F.Muell. ex Müll.Arg. is formally recognised in Western Australia. Specimens of this species have previously been included in a broad concept of *P. virgatus* G.Forst., a name that still encompasses several distinct taxa in Western Australia. Detailed studies of the *P. virgatus* complex across its entire range are required to determine the correct application of this name. *Phyllanthus* sp. B Kimberley Flora (T.E.H. Aplin et al. 809) is one of a number of taxa included under *P. virgatus* by Hunter and Bruhl (1997a), but it is here reinstated as a distinct species that will soon be named (Telford & Bruhl, in prep.).

Phyllanthus rhytidospermus Müll.Arg. has long been recognised as incorrectly placed in *Phyllanthus* and is listed on *FloraBase* (Western Australian Herbarium 1998–) as *Sa.* sp. Central Ranges (D.J. Edinger et al. 2420). It will soon be transferred to *Synostemon*.

Sauropus hubbardii Airy Shaw and *Sa. lissocarpus* (S.Moore) Airy Shaw are recorded for Western Australia, both having previously been confused with *Sa. trachyspermus* (F.Muell.) Airy Shaw by Wheeler (1992).

Sauropus rigidulus (Müll.Arg.) Airy Shaw is formally recorded from Western Australia where it has been listed under the phrase name *Sa.* sp. Cockburn Range (D. Dureau 81) and a full description is provided as the only recent description was based solely on the type specimen (Airy Shaw 1980).

This species is distributed from the south-east Kimberley, across the Northern Territory, to the Gulf of Carpentaria in Queensland.

Sauropus sp. A Kimberley Flora (T.E.H. Aplin et al. 929) was incorrectly included in *Sa. trachyspermus* by Hunter and Bruhl (1997b) and will soon be described as a new species of *Synostemon* (Telford *et al.*, in prep.).

Sauropus torridus Hunter & Bruhl was described as a new species by Hunter and Bruhl (1997b). It is here included in a somewhat morphologically variable *Sy. glaucus* F.Muell. Part of the concept of *P.* sp. B in Wheeler (1992) is also referable to *Sy. glaucus*.

Synostemon ramosissimus F.Muell. is currently listed as *Sa. ramosissimus* (F.Muell.) Airy Shaw in Western Australia and, as applied, is the same taxon as *Sa.* sp. Woolgorong (M. Officer s.n. 10/8/94). This phrase-named taxon will soon be described as a subspecies of *Sy. ramosissimus*.

Synostemon trachyspermus (F.Muell.) I.Telford & Pruesapan should be excluded from Western Australia's plant census as the name has been misapplied against *Sa. hubbardii*, *Sa. lissocarpus* and *P. rhytidospermus*.

Methods

All measurements are based on dried herbarium material. *Phyllanthus eremicus* has been examined in the field by the first author. Descriptions are largely based on the format of Hunter and Bruhl (1997), except that the term 'stem leaves', the leaves or cataphylls on the usually more or less erect primary stems, replaces their 'branch leaves', a term we consider too similar to the 'branchlet leaves' of the usually spreading branchlets. Cited type specimens of existing names have been examined by the second author with images of most types seen by the first author.

Taxonomy

Phyllanthus L.

Current systematic placement of species of *Phyllanthus* is as follows: *P. eremicus*, *P. fuernrohrii*, *P. hamelinii* and *P. indigoferoides* are all placed in *P.* subgen. *Lysiandra*, a subgenus characterised by shrub habit, narrowly triangular stipules, laminate stem leaves (lacking phyllanthoid branching) and minutely striate or smooth seeds (Telford, unpubl. data); *P. baccatus* is in *P.* subgen. *Kirganelia* (Juss.) G.L.Webster, characterised by shrub or tree habit, stem leaves as cataphylls (phyllanthoid branching present) and fruit a berry; *P. minutiflorus* and *P.* sp. B Kimberley Flora are placed in *P.* sect. *Macraea* (Wight) Baill., characterised by herbaceous or subshrub habit, cordate or auriculate bicoloured stipules, laminate stem leaves and verrucate seeds. Taxa are treated below in alphabetical order.

Phyllanthus baccatus F.Muell. ex Benth., *Fl. Austral.* 6: 102 (1873). *Syntypes*: Vansittart Bay and Greville island, Prince Regent R., N.W. coast, [Western Australia,] *s. dat.*, *A. Cunningham s.n.* (*syn*: K); Victoria R., [Northern Territory,] *s. dat.*, *F. Mueller s.n.* (*syn*: K); Port Darwin, [Northern Territory,] *s. dat.*, *Schultz* 860 (*syn*: K).

[*Phyllanthus ciccoides auct. non* Müll.Arg.: K. Menkhorst & I.D. Cowie, *Survey Wildlife Veg. Purnululu (Bungle Bungle) Nat. Park*, p. 33 (1992); D.T. Liddle, J. Russell-Smith, J. Brock, G.J. Leach, & G.T. Connors, *Atlas Vasc. Rainfor. Pl. North. Terr.*, p. 47 (1994).]

[*Phyllanthus reticulatus auct. non* Poir.: J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 622, Figure 190D (1992); C.R. Dunlop, G.J. Leach & I.D. Cowie, *Fl. Darwin Reg.* 2: 231, Figure 75 (1995).]

Full descriptions and illustrations of this species are available in Wheeler (1992) and Dunlop *et al.* (1995), both as *P. reticulatus* Poir.

Conservation status. Reasonably widespread and locally common. Not considered to be at risk.

Notes. The names *P. reticulatus* and *P. ciccoides* Müll.Arg. have frequently been misapplied to this species and these taxa do not occur in Western Australia, all material being assignable to *P. baccatus*. Luo *et al.* (2011) have shown *P. reticulatus s. str.* to be an Asian species and *P. baccatus* is not placed with it in molecular analysis using nrITS sequence data (S.S. Renner pers. comm.).

Phyllanthus eremicus R.L.Barrett & I.Telford, *sp. nov.*

Type: near Shay Gap, Western Australia [precise locality withheld for conservation reasons], 27 July 2013, *R.L. Barrett* RLB 8250 (*holo*: PERTH 08614490; *iso*: DNA, NE).

Phyllanthus sp. C, J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 624, Figures 190J, 191J (1992); K.F. Kenneally, D. Choules Edinger & T. Willing, *Broome and Beyond*, p. 106, pl. (1996).

Phyllanthus sp. C Kimberley Flora (N.T. Burbidge 1400), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Erect monoecious *subshrub* 30–50 cm high, to 50 cm wide, primary stem woody, to 3.5 mm diam., glabrous; branching pattern non-phyllanthoid. *Stipules* persistent, membranous, narrowly triangular to subulate, 0.7–1.1 mm long, brown, entire, glabrous; base rounded; apex acute to acuminate. *Stem leaves* laminate, similar to branchlet leaves. *Branchlets* persistent, terete, 6–20 cm long, 0.4–0.7 mm diam., glabrous. *Branchlet leaves* alternate, distichous, mid-green, remaining green when dry, symmetrical, flat when fresh and dried. *Leaves* shortly petiolate; *petiole* 0.5–1.1 mm long, 0.30–0.35 mm diam., terete, glabrous. *Lamina* 3.7–12.5(–15) mm long, 1.8–4.7(–5.9) mm wide, blade oblong to obovate, light green, slightly paler below, pinnately veined, glabrous; base symmetrical, gradually tapering; apex obtuse or apiculate; margins plane, not or scarcely thickened; midrib not or scarcely raised, lateral veins inconspicuous. *Bracts* and *bracteoles* deciduous, glabrous. *Inflorescences* at least sometimes bisexual with the sexes mixed, indeterminate, axillary, sessile. *Male flowers* usually solitary or sometimes clustered, 2 or 3 per cluster; *pedicels* 0.5–1.5 mm long, glabrous; *tepals* 6, free, imbricate, ascending to divergent, elliptic to ovate, 1.0–1.5 mm long, 0.6–0.7 mm wide, obtuse, pale green outside, yellow inside, glabrous, margins entire, white; *disk* comprising discrete lobes, lobes *c.* 0.2 mm wide, lenticular, yellow; *stamens* 3, erect; *filaments* free, erect, terete, 1 mm long; *anthers* extrorse, divaricate, globular to ellipsoid, 0.20–0.25 mm long, with a broad connective, opening by longitudinal slits; *pollen* globular. *Female flowers* usually solitary or sometimes 2 clustered; *pedicels* jointed, at anthesis 4.5–7.0 mm long, slightly thickened upwards, 0.3–0.5 mm diam., in fruit 5.7–7.1 mm long, 0.3–0.6 mm diam., glabrous; *tepals* 6, free, at anthesis ascending to divergent, in fruit divergent to reflexed, elliptic, 2.5–3.2 mm long, 2.1–2.4 mm wide, obtuse, white, green to yellow, with a distinct white margin, glabrous; *disk* crenate, 0.7–0.8 mm wide, glabrous, yellow; *styles* 3, free, divided for half of their length, recurved, cream, 0.5 mm long, 0.3 mm diam., narrow-terete, glabrous, branches linear; *ovary* 0.3–0.5 mm long, 0.3–0.6 mm diam., transversely ellipsoid and apically depressed, smooth, glabrous. *Fruit* a septicidal capsule, transversely ellipsoid and apically depressed, 3.0–3.3 mm long, 4.2–6.2 mm diam., pale green,

cartilaginous, smooth, glabrous, grooved septicidally; *column* persistent, angular-ovoid, 1.2–1.6 mm long. *Seeds* pale brown, prismatic, laterally compressed, 2.2–2.3 mm long, 1.4–1.7 mm diam., smooth to very minutely transversely striate, appearing scaly; *hilum* slightly depressed, ovate, unbordered, cavity more or less basal. (Figure 1)

Figure 1. *Phyllanthus eremicus*. A – habit showing single stem and many branches, B – woody stem showing slightly peeling bark; C – flowering and fruiting branchlet with both female and male flower; D – female flower; E – male flowers; F – fruit and partially enclosing sepals. Images from *R.L. Barrett* RLB 8250. Photographs by R.L. Barrett.

Diagnostic characters. Distinguished from *P. aridus* by the following combination of characters: *subshrub* with woody stems; *leaves* 3.7–12.5(–15) mm long, 1.8–4.7(–5.9) mm wide, lacking prominent lateral veins; *male flowers* on pedicels 0.5–1.5 mm long; *stamens* with free filaments and globular anthers; *seeds* smooth to very minutely transversely striate or appearing scaly.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 25 July 2013, *R.L. Barrett* RLB 8212 (CANB, NE, PERTH); 9 July 1941, *N.T. Burbidge* 1400 (PERTH); 6 June 1993, *B.J. Carter* 652 (BRI, CANB, DNA, PERTH); 13 Sep. 1982, *L.A. Craven* 7566 (CANB, PERTH); 13 Aug. 1997, *A.A. Mitchell* PRP 1762 (NE, PERTH); 8 July 1992, *A.A. Mitchell* 2600 (DNA, PERTH); 10 Apr. 2008, *Woodman Environmental Consulting* Opp 115 (PERTH). NORTHERN TERRITORY: 10 Apr. 1959, *G. Chippendale* 5606 (NT, PERTH); 22 May 1936, *J.B. Cleland s.n.* (AD); 11 May 1977, *P.K. Latz* 7048 (DNA, BRI).

Phenology. Flowering and fruiting May to August.

Distribution and habitat. Occurs between Broome, Anna Plains Station and the Edgar Range south to Callawa Station and Shay Gap in Western Australia, east to the Tanami Desert in the Northern Territory. Grows on rocky outcrops or on red sandplains with low shrubs of *Acacia*, *Grevillea* and *Hakea* over *Triodia epactia*.

Conservation status. *Phyllanthus eremicus* is to be listed as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.).

Etymology. The epithet, which is Greek, pertaining to desert sand, refers to the arid environment in which this species grows.

Notes. Included under a broad concept of *P. aridus* by Hunter and Bruhl (1997a) but distinguished by larger leaves (2.5–7 mm long in *P. aridus*), pedicellate male flowers, larger fruiting sepals (1–2 mm long in *P. aridus*) and smoother seeds. The distribution of this species contrasts with *P. aridus* which occurs in the high rainfall zone of the North Kimberley where it is only seasonally dry.

The vernacular name of Desert Phyllanthus is recommended.

Phyllanthus fuernrohrii F.Muell., *Trans. Philos. Soc. Victoria* 1: 15 (1854); *Diasperus fuernrohrii* (F.Muell.) Kuntze, *Revis. Gen. Pl.* 2: 599 (1891). *Type*: On gravelly sandhills near the Murray, [?South Australia,] *s. dat.*, *F. Mueller s.n.* (*holo*: ?MEL, *n.v.*).

Full descriptions are available in Airy Shaw and Kalotas (1981) and Weber (1986).

Specimen examined. WESTERN AUSTRALIA: [locality withheld for conservation reasons] 2 Aug. 2001, *R. Bates* 58309 (AD, NE).

Conservation status. *Phyllanthus fuernrohrii* is to be listed as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). While reasonably widespread in the Northern Territory, South Australia, Queensland and New South Wales, in Western Australia it is only known from a single collection in the Wingellina Hills.

Notes. This name has previously been misapplied in Western Australia to specimens here recognised as *P. hamelinii* (see notes below for differences). It is noted here that *P. fuernrohrii s. str.* has recently been recorded from Western Australia where it is currently listed as an excluded name. *Phyllanthus fuernrohrii* is widely distributed in the Northern Territory, South Australia, Queensland and New South Wales.

Phyllanthus hamelinii I.Telford & R.L.Barrett, *sp. nov.*

Type: North West Cape, *c.* 5 km west of Exmouth homestead, Western Australia, 3 October 1975, *J.Z. Weber* 4919 (*holo*: PERTH 03997669; *iso*: AD 97550309).

Phyllanthus fuernrohrii var. *latifolius* Müll.Arg. in A. DC., *Prodr.* 15: 373 (1866). *Type*: Baie des Chien-marins [Shark Bay, Western Australia], 1801, ?*Baudin s.n.* (*holo*: G-DC G00325484; *iso*: A (fragment), GH, P).

Phyllanthus sp. Coastal North West (J.Z. Weber 4919), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Erect to spreading, monoecious *subshrub*, 10–50 cm high, 20–40 cm wide, primary stem woody, to 3.0(–9.5) mm diam., minutely papillose to glabrescent; branching pattern non-phyllanthoid. *Stipules* persistent, membranous, triangular, 1.3–1.8 mm long, brown, entire or slightly fimbriate, minutely papillose to glabrescent; base somewhat cordate; apex acute. *Stem leaves* laminate, similar to branchlet leaves, usually larger. *Branchlets* persistent, with decurrent ribs, 2–18 cm long, 0.7–1.9 mm diam., moderately to densely papillose or sometimes glabrescent. *Branchlet leaves* alternate, distichous, greyish green or sub-glaucous, remaining green when dry, symmetrical, flat, drying undulate. *Leaves* shortly petiolate; *petiole* 0.6–1.2 mm long, 0.30–0.40 mm diam., terete, glabrous. *Lamina* 4.5–21 mm long, 2.8–11 mm wide, blade obovate, light green to greyish green, slightly paler below, pinnately veined, moderately papillose to glabrescent; base symmetrical, obtuse; apex obtuse or shortly apiculate, occasionally mucronate; margins plane, not or scarcely thickened; midrib not or scarcely raised, lateral veins inconspicuous. *Bracts* and *bracteoles* often persistent, papillose. *Inflorescences* at least sometimes bisexual with the sexes mixed, indeterminate, axillary, sessile. *Male flowers* 1–3 per fascicle; *pedicels* 2.2–5.1 mm long, glabrous; *tepals* 6, free, imbricate, ascending to divergent, elliptic or obovate, 1.4–2.0 mm long, 0.9–1.2 mm wide, obtuse, pale green outside and inside, papillose on both sides, margins entire, white; *disk* comprising discrete lobes, lobes *c.* 0.4 mm wide, lenticular, reddish; *stamens* 3, erect; *filaments* connate, erect, terete, 0.6–0.8 mm long; *anthers* extrorse, divaricate, ellipsoid, 0.4–0.5 mm long, with a broad connective, opening by longitudinal slits; *pollen* globular. *Female flowers* solitary, coaxillary with males; *pedicels* jointed, at anthesis 3.5–10.2 mm long, slightly thickened upwards, 0.2–0.5 mm diam., slightly elongating in fruit, 5.9–7.3 mm long, 0.2–0.5 mm diam., papillose; *tepals* 6, free, at anthesis ascending to divergent, in fruit divergent to reflexed, elliptic to broadly obovate, 2.3–2.8 mm long, 1.6–2.8 mm wide, obtuse, green with white margins; *disc* lobed, 1.9–2.1 mm wide, glabrous, brown; *styles* 3, free, divided for more than half their length, spreading, cream, 0.4 mm long, 0.3 mm diam., terete, glabrous, branches linear; *ovary* 0.6–0.7 mm long, 0.6–0.7 mm diam., transversely ellipsoid and apically depressed, smooth, minutely papillose. *Fruit* a septicidal capsule, transversely ellipsoid and apically depressed, 2.5–2.8 mm long, 3.5–4.3 mm diam., pale green, cartilaginous, smooth, minutely papillose, grooved septicidally; *column* persistent, angular-ovoid, 1.1–1.4 mm long. *Seeds* dark brown, prismatic, laterally compressed, 2.0–2.4 mm long, 1.7–1.9 mm diam., smooth to very finely transversely striate or appearing scaly; *hilum* depressed, more or less circular, unbordered, cavity more or less basal. (Figure 2)

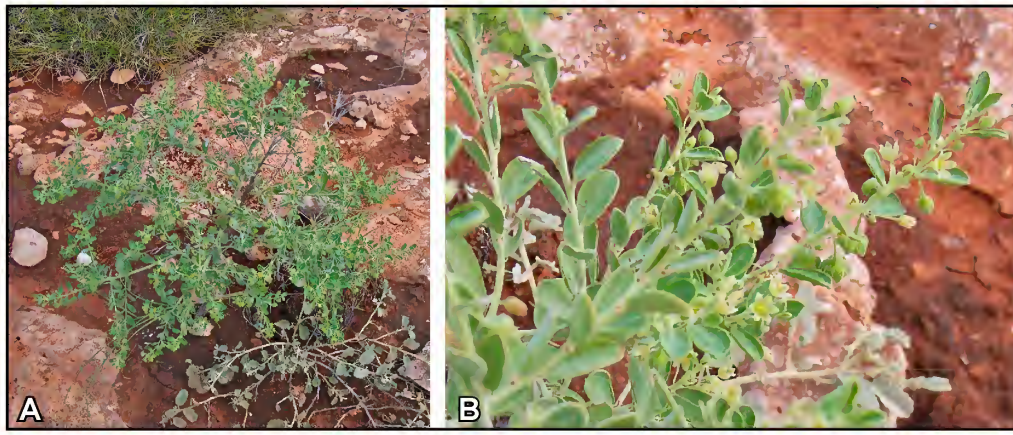

Figure 2. *Phyllanthus hamelinii*. A – habit on loam over limestone with *Triodia*; B – flowering and fruiting branchlets. Images from *J. English* 179. Photographs by J. English.

Diagnostic characters. Distinguished from *P. fuernrohrii* by the following combination of characters: *leaves* 4.5–21 mm long, 2.8–11 mm wide, blade obovate, light green to greyish green, moderately papillose to glabrescent, base symmetrical, obtuse; *tepals* of female flowers free, 2.3–2.8 mm long, 1.6–2.8 mm wide; *seeds* 2.0–2.4 mm long, 1.7–1.9 mm diam., smooth to very finely transversely striate or appearing scaly, with unbordered hilum.

Other specimens examined. WESTERN AUSTRALIA: Blowholes Rd, 20 km NW of North West Coastal Hwy, Beagle Hill area, 27 Oct. 2004, *G. Cassis, M. Wall, C. Symonds, N. Tartanic & C. We* 17-152 (AMNH, PERTH); site plot DI11, *c.* 6.25 km N of Observation Hillock, Dorre Island, Shark Bay, 3 Sep. 1998, *S.J. Claymore & A.S. Weston* 45 (PERTH); site plot BI17, *c.* 1.3 km WNW of Wedge Rock, Bernier Island, Shark Bay, 29 Aug. 1998, *S.J. Claymore & A.S. Weston* 57 (PERTH); site plot BI01, *c.* 700 m W of Red Cliff Point, Bernier Island, Shark Bay, 26 Aug. 1998, *S.J. Claymore & A.S. Weston* 58 (PERTH); *c.* 500 m SE of Mangrove Bay, turnoff at top of ridge, 28 July 2007, *J. English* 179 (PERTH); 22.5 km N of Learmonth, 29 Aug. 1960, *A.S. George* 1275 (PERTH); 53 km N of Carnarvon on [Point] Quobba road, 20 Feb. 1962, *A.S. George* 3249 (PERTH); Cape Range, 3 km N of Pitgramunne Well, 27 May 1965, *D.W. Goodall* 2261 (PERTH); Vlamming [Vlamingh] Head, North West Cape, 19 July 1992, *G.J. Keighery* 14751 (PERTH); 11 km NE of Cape Cuvier, N of Carnarvon. (Site: cu6), 20 Aug. 1994, *G.J. Keighery & N. Gibson* 1193 (PERTH); Hermite Island, Montebello Islands, 23 Oct. 2000, *K.F. Kenneally* 11582 (PERTH); Gladstone Beach, NW end Trimouille Island, Montebello Islands, 24 Oct. 2000, *K.F. Kenneally* 11599 (PERTH); Exmouth Gulf Station, 22 Aug. 1995, *J. Stretch* 4 (PERTH); near N White Beach transect, Dorre Island, 14 Aug. 1977, *A.S. Weston* 10504 (CANB, PERTH); Dorre Island, 16 Aug. 1977, *A.S. Weston* 10518 (PERTH); 25 km NNW of Carnarvon, 25 Sep. 1987, *P.G. Wilson* 12606 (PERTH); *c.* 2 km inland (E) of Cape Cuvier, *c.* 76 km NW of Carnarvon, 29 Sep. 1987, *P.G. Wilson* 12721 (PERTH).

Phenology. Flowering and fruiting mainly in May to October.

Distribution and habitat. Endemic to coastal Western Australia between North West Cape and Shark Bay. Grows in low coastal shrubland in calcareous sand on limestone or red sandy loam; recorded from behind foredunes, on dune slopes, on ridge crests, in seasonal watercourses and near salt flats. Grows in association with *Acacia coriacea*, *Alyogyne pinoniana*, *Atriplex paludosa*, *Banksia ashbyi*,

Beyeria cinerea, *Diplolaena grandiflora*, *Eremophila glabra*, *Eucalyptus oraria*, *Frankenia pauciflora*, *Olearia axillaris*, *Paractaenum novae-hollandiae*, *Rhagodia preissii*, *Sclerolaena uniflora*, *Spinifex longifolius* and *Triodia plurinervata*.

Conservation status. Reasonably widespread and locally common. Not considered to be threatened at present.

Etymology. The epithet honours Baron J.F.E. Hamelin, commander of the *Naturaliste* on the Baudin expedition in 1801, on which the first collection of this taxon was made. It is uncertain which member(s) of the expedition made the original collection.

Notes. Formerly included under *P. fuernrohrii*, but that species differs in having mostly larger, elliptic leaves (to 42 mm long), smaller sepals (*c.* 1.5 mm long) and seeds with a bordered hilum. Superficially vegetatively similar to the almost sympatric *Sa. crassifolius* (Müll.Arg.) Airy Shaw, which differs in having flowers that lack discs, ovoid fruit and crescentiform seeds with a large ventral hilum.

The vernacular name of Shark Bay Phyllanthus is recommended.

The name *P. fuernrohrii* was misapplied to this species for many years (e.g. Green 1985). Bentham (1873) questioned the application of *P. fuernrohrii* to specimens from the Western Australian coast and Müller Argoviensis (1866) named this taxon as *P. fuernrohrii* var. *latifolius* Müll.Arg. The varietal epithet is preoccupied at specific rank by *P. latifolius* Sw., so a new name is chosen here based on a new type specimen.

Phyllanthus indigoferoides Benth., *Fl. Austral.* 6: 110 (1873). *Type*: 'N. Australia, York Sound, NW coast', [Western Australia,] 1820, *A. Cunningham* 285 (*holo*: K; *iso*: MEL, NSW).

Phyllanthus sp. D, J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 624, Figures 190A, 191A (1992).

Phyllanthus sp. D Kimberley Flora (C.R. Dunlop 5302), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Conservation status. *Phyllanthus indigoferoides* and *P.* sp. D Kimberley Flora are both listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora. Few collections are known and this conservation status remains appropriate when the two names are combined.

Notes. This species is distinctive in Western Australia for its dense, papillate indumentum on the leaves and floral parts. The application of *P. indigoferoides* was unknown to Wheeler (1992) who provided a description as *P.* sp. D. Formal assessment of these two names has not previously been undertaken. Examination of specimens, including the type of *P. indigoferoides*, has shown that this name is correctly applied to *P.* sp. D which is formally listed here as a synonym.

Phyllanthus indigoferoides appears to be restricted to the north-east Kimberley region and adjacent parts of the Northern Territory.

Phyllanthus minutiflorus F.Muell. ex Müll.Arg., *Linnaea* 34: 75 (1865); *Phyllanthus simplex* var. *minutiflorus* (F.Muell. ex Müll.Arg.) Domin, *Beitr. Fl. Pflanz. Austral.* 877 (1927). *Type citation*: 'In Nova Hollandia secus Victoria River, in Arnhemsland tractus M. Adam Range (Ferd. Muell.! In hb. DC.).' *Type*: Victoria R., Arnhem Land, [Northern Territory,] [received] 1863, *F. Mueller* (*holo*: G-DC G00318221); ?*iso*: K 001056770 [Upper Victoria R., *s. dat.*], K 001056768 [Victoria R., July 1855], K 001056771 [Victoria R., near Main Camp, May 1856]).

Conservation status. Reasonably widespread and locally common. Not considered to be threatened at present.

Notes. The type citation quotes a distribution range observed by Mueller and included in a hand-written description attached to the holotype sheet. However there is only a single sheet in G-DC, so the holotype is unequivocal. There are additional sheets at K that may be isotypes, but there was clearly more than one collection made by Mueller and the collection date was not included on the sheet in G-DC, so a definite match cannot be made.

Not previously recognised in Western Australia, *P. minutiflorus* was included under a broad concept of the very variable *P. virgatus* by Wheeler (1992) and Hunter and Bruhl (1997a). *Phyllanthus virgatus* is a more robust, perennial subshrub differing in larger female flowers on long pedicels, and larger capsules and seeds. *Phyllanthus minutiflorus* is a small annual, usually a wet season ephemeral. Both species are in *P.* subgen. *Macraea*, characterised by auriculate, acuminate, lacerate, bicoloured stipules, laminate stem leaves and verrucose seeds. *Phyllanthus minutiflorus* has continued to be recognised in the Northern Territory and Queensland. A full description and illustration is provided by Dunlop *et al.* (1995).

There are numerous collections from Western Australia that are still referable to *P. virgatus s. lat.*, a widespread and taxonomically challenging species complex. It is clear that multiple additional taxa should be recognised in the Kimberley region, but further studies are required to determine species limits and the correct application of additional names.

Phyllanthus rhytidospermus Müll.Arg., *Linnaea* 34: 70 (1855); *Glochidion rhytidospermum* (Müll.Arg.) H.Eichler, *Fl. S. Austral. Suppl.* (2nd edn): 210 (1965). *Type citation*: 'In Nova Hollandia ad Victoria River (Ferd. Müller! in hb. DC.).' *Type*: [Depot Ck, upper] Victoria R., [Northern Territory, Mar. 1856,] *F. Mueller s.n.* (*holo*: G-DC G00325158; *iso*: MEL 1594270).

Sauropus sp. Central Ranges (D.J. Edinger et al. 2420), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

[*Sauropus trachyspermus auct. non* (F.Muell.) Airy Shaw: J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 628 (1992) and Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014], both *p.p.* as to all except specimens from off-shore islands and the Kimberley Research Station.]

Conservation status. Reasonably widespread and locally common. Not considered to be threatened.

Notes. *Phyllanthus rhytidospermus* was placed in synonymy under *Sa. trachyspermus* by Airy Shaw (1980) and no combination is available under *Sauropus* or *Synostemon*. A new combination will be made available under *Synostemon* in the near future (Telford *et al.*, in prep.). It is a distinctive perennial

with a thickened rootstock (*Sa. trachyspermus* is an annual) and has smaller seeds with fine tubercules on the outer face (*vs* many prominent protuberances).

Phyllanthus sp. **B Kimberley Flora (T.E.H. Aplin et al. 809)**, Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Phyllanthus sp. B, J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 624 (1992), *p.p.*

Conservation status. Reasonably widespread and locally common. Not considered to be threatened.

Notes. Included under *P. virgatus* by Hunter and Bruhl (1997a). This distinctive multi-stemmed subshrub is a member of *P.* subgen. *Macraea*. It is distinctive in the floral segments of the male flowers being connate only at the base, having a schizocarp 3–5 mm across and seeds 2–4 mm long with deeply sculptured surfaces. Widespread and common in seasonally damp habitats across tropical Australia, it will be named as a new species (I. Telford & J. Bruhl pers. comm).

A specimen of *Sa. glaucus* was also erroneously included in this taxon by Wheeler (1992).

Sauropus Blume

Notes and further status details are presented on those taxa that require nomenclatural adjustment from their current treatment on *FloraBase* (Western Australian Herbarium 1998–). A full description of *Sa. rigidulus* is provided as the description provided by Airy Shaw (1980) was based solely on the type specimen.

Sauropus hubbardii Airy Shaw, *Kew Bull.* 355: 677 (1980). *Type*: Nonda, between Hughenden and Cloncurry in mixed grassland in heavy dark brown soil, Queensland, 160 m, 6 February 1931, *Hubbard & Winders* 7295 (*holo*: K).

[*Sauropus trachyspermus auct. non* (F.Muell.) Airy Shaw: J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 628 (1992), *p.p.* as to *N.T. Burbidge* 5781.]

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 17 Apr. 1958, *N.T. Burbidge* 5781 (CANB, PERTH); *s. dat.*, *E.C.B. Langfield* 376 (CANB, PERTH); 20 July 1993, *A.A. Mitchell* 3226 (NE, PERTH).

Conservation status. *Sauropus hubbardii* is to be listed as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm). While reasonably widespread in the Northern Territory and Queensland, in Western Australia it is only known from blacksoil plains associated with the Ord River Irrigation Area and is possibly locally threatened by agricultural development. The three known collections are from quite close proximity to each other.

Notes. This species was partly included in *Sa. trachyspermus* by Wheeler (1992: 628) based on the inclusion of a specimen collected near the Kimberley Research Station with 'leaves to 20 mm long and more deeply lobed styles'. The name *Sa. hubbardii* has not previously been in use in Western Australia. A detailed description is available in Airy Shaw (1980) and a brief description and illustration is provided by Purdie *et al.* (2008).

Sauropus lissocarpus (S.Moore) Airy Shaw, *Kew Bull.* 35: 680 (1980); *Phyllanthus lissocarpus* S.Moore, *J. Linn. Soc., Bot.* 45: 215 (1920). *Type*: Groote Eylandt, [Northern Territory,] 15 January 1803, *R. Brown* [Bennett No. 3606] (*holo*: BM 001014832; *iso*: BM 001014833).

Phyllanthus arnhemicus S.Moore, *J. Linn. Soc., Bot.* 45: 215 (1920). *Type*: Arnhem S. Bay, [Northern Territory,] 1803, *R. Brown* [Bennett No. 3597] (*holo*: BM [apparently not databased]).

[*Sauropus trachyspermus auct. non* (F.Muell.) Airy Shaw: J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 628 (1992), *p.p.* as to 'specimens from off-shore islands...'.]

Selected specimens examined. WESTERN AUSTRALIA: One Arm Point, N Dampier Peninsula, 25 June 1989, *B.J. Carter* 403 (PERTH); abandoned Camden Harbour settlement site, Camden Harbour, 30 May 1987, *K.F. Kenneally* 10083 (BRI, DNA, PERTH); mouth of Trent River, Yampi Peninsula, W of Kimbolton Homestead, 10 Mar. 2001, *A.N. Start per R.L. Barrett* 1899 (NE, PERTH); SW side of Mt Page, King Leopold Range, S of Walcott Inlet, 14 Mar. 2001, *A.N. Start & R.L. Barrett* 2351 (NE, PERTH); Princess May Ranges, 21.6 km due N of Kings Cascades, 25 Jan. 2007, *R.L. Barrett* 3921 *& M.D. Barrett* (NE, PERTH).

Conservation status. Reasonably widespread and locally common. Not considered to be threatened at present.

Notes. This species was included in *Sa. trachyspermus* by Wheeler (1992: 628) based on the inclusion of caducous-leaved specimens from off-shore islands with 'floral segments which are slightly broader and often obtuse and schizocarps which are depressed globular rather than ovoid'. As the concept of Wheeler (1992) was quite confused, a detailed list of specimens is provided above. A description is provided by Airy Shaw (1980).

Sauropus rigidulus (Müll.Arg.) Airy Shaw, *Kew Bull.* 35(3): 684 (1980); *Phyllanthus rigidulus* Müll.Arg., *Linnaea* 34: 72 (1865); *Diasperus rigidulus* (Müll.Arg.) Kuntze, *Rev. Gen. Pl.* 2: 600 (1891). *Type citation*: 'Novae Hollandia septentrionali ad Sinum Carpentariae (Ferd. Muell.! In hb. DC.).' *Type*: Gulf of Carpentaria, [Northern Territory,] [received] 1863, *F. Mueller s.n.* (*holo*: G-DC G00325418; *iso*: K 001081091).

Sauropus sp. Cockburn Range (D. Dureau 81), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Erect, monoecious *shrubs*, 60–90 cm tall, 30–50 cm wide, primary stem woody, to 7.5 mm diam., pilose to glabrescent, branching pattern non-phyllanthoid. *Stipules* persistent, free, chartaceous, triangular, 0.8–1 mm long, dark brown, entire, densely pilose; base truncate to rounded; apex acuminate. *Stem leaves* basally laminate, becoming scale-like cataphylls distally, brown, pilose. *Branchlets* persistent, terete for most of their length but angular at the apices, 11–45 cm long, 0.8–1.6 mm diam., densely pilose to hirsute. *Branchlet leaves* alternate, distichous, dull green when fresh and dried, slightly asymmetrical, flat, drying undulate, jointed. *Leaves* petiolate; *petiole* 0.5–1.1 mm long, 0.4–0.6 mm diam., terete, persistently pilose. *Lamina* 4.8–12.3 mm long, 2.6–7.7 mm wide, blade ovate to broadly ovate, usually slightly asymmetrical, although some may appear symmetrical, flat, dull green when fresh and dried, obscurely pinnately 3-veined per side, pilose with spreading, dense hairs; base rarely oblique, rounded to obtuse; apex erect, acuminate to acute or mucronate; margins plane, thickened (more so abaxially); midrib slightly raised, lateral veins usually inconspicuous. *Bracts and bracteoles*

persistent, pilose. *Inflorescence* unisexual, axillary, the female distal. *Male flowers* occasionally 1, usually 2 or 3 per bracteate cluster, the inflorescence eventually shortly pedunculate (peduncle to 1 mm); *pedicels* 0.6–1.1 mm long, with pilose indumentum; *tepals* 6, free, imbricate, erect, elliptic, 1.7–2.0 mm long, 0.7–1.0 mm wide, acute, green, abaxially densely pilose; *stamens* 3, symmetrical, erect; *filaments* completely connate, erect, terete, 0.2 mm long; *anthers* erect, linear, 0.65 mm long, their connectives and apical appendages completely connate, 0.1 mm long, yellow; *loculesl* longitudinal. *Female flowers* solitary; *pedicels* at anthesis 0.7–1.4 mm long, 0.7–1.1 mm diam., in fruit 1.3–1.7 mm long, 0.8–1.2 mm diam., pilose; *tepals* 6, free, at anthesis erect to ascending, in fruit appressed to divergent, elliptic, ovate to obovate, 1.9–2.3 mm long, 0.7–1.1 mm wide, obtuse, green, abaxially densely pilose; *styles* well developed, 3, connate, erect, green, 0.7–1.0 mm long, 0.7–0.8 mm diam., cylindrical, sparsely pilose; *ovary* 1–1.2 mm long, 0.7–0.9 mm diam., ovoid to ellipsoid, smooth, puberulous. *Fruit* a septicidal capsule, ovoid, 6.1–8.0 mm long, 5.6–6.9 mm diam., green, smooth, puberulous or pilose, grooved septicidally; *apex* obtuse; *column* persistent, obconical, 3.8–4.2 mm long. *Seeds* pale brown, crescentiform, laterally compressed, 5.4–5.8 mm long, 2.1–2.5 mm diam., minutely granular; *hilum* greatly depressed, elliptic, more or less central. (Figure 3)

Diagnostic characters. Distinguished from *Sa. glaucus* by the following combination of characters: *shrub* to 90 cm with woody stem; *stipules* 0.8–1 mm long, dark brown, triangular, densely pilose, margins entire; *leaf lamina* 4.8–12.3 mm long, 2.6–7.7 mm wide, dull green; *male flowers* usually 2 or 3; *female flowers* with tepals 1.9–2.3 mm long, 0.7–1.1 mm wide; *fruit* ovoid, 6.1–8.0 mm long, 5.6–6.9 mm diam.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 7 Apr. 2013, *M.D. Barrett, R.L. Barrett & B.M. Anderson* MDB 4259 (PERTH); 7 Apr. 2013, *M.D. Barrett, R.L. Barrett & B. Anderson* MDB 4283 (NE, PERTH); 20 July 1991, *I.D. Cowie* 1915 (CANB, DNA, MEL, PERTH); 22 Mar. 1992, *D. Dureau* 81 (PERTH). NORTHERN TERRITORY: Bullo River Station, 9 May 2008, *I.D. Cowie* 12092 (DNA, MEL, MO, NE); upper Wearyan River, Jan. 1989, *J. Russell-Smith* 7000 *& D. Lucas* (DNA); sandstone plateau near Glyde River, McArthur River area, 29 Jan. 1976, *L.A. Craven* 3477 (A, BRI, CANB, DNA, PERTH); Mitchebo Waterhole, Mittiebah Station, 27 Mar. 1981, *J.R. Maconochie* 2588 (DNA, NT). QUEENSLAND: amphitheatre, 210 km N of Camooweal, N of Musselbrook Mining Camp, 18 July 1998, *R.J. Cumming* 17631 (BRI, DNA, NE).

Phenology. Flowering and fruiting recorded for March to July.

Distribution and habitat. In Western Australia, only known from three localities in the Osmond and Cockburn Ranges in the south-east Kimberley where it grows on a rough sandstone plateau with scattered shrubs. Associated species include *Acacia adoxa*, *A. lycopodiifolia*, *A. tumida*, *Boronia minutipinna*, *Cajanus acutifolius*, *Dodonaea hispidula*, *Grevillea miniata*, *G. refracta*, *Hibiscus squarrulosus*, *Tephrosia valleculata* and *Triodia* spp. Widespread in the Top End of the Northern Territory and extending into Queensland near the Gulf of Carpentaria.

Conservation status. *Sauropus rigidulus* is to be listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (A. Jones pers. comm.). This species is probably fire sensitive and quite rare in Western Australia. Around 12 locations in the Osmond Range have been surveyed, and only three small populations have been located there. Frequency in the Cockburn Range is unknown. This species is widespread across the Northern Territory and Queensland where it is not threatened.

Figure 3. *Sauropus rigidulus*. A – fertile branches; B – woody stem showing slightly peeling bark; C – male flowers (lower branchlet); D – female flowers; E – fruit; F – dehisced fruit with persistent axis. Images from *M.D. Barrett, R.L. Barrett & B.M. Anderson* MDB 4259. Photographs by R.L. Barrett.

Etymology. The epithet refers to the rigid, erect habit of this species.

Notes. Relationships have been shown (Pruesapan *et al.* 2012) to be with a group of mainly Top End species including *Sa. glaucus* and *Sa. stenocladus* (Müll.Arg.) J.T.Hunter & J.J.Bruhl characterised by stamens completely connate into an apiculate androphore.

The vernacular name of Shrubby Synostemon is recommended.

Sauropus sp. **A Kimberley Flora (T.E.H. Aplin et al. 929)**, Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Sauropus sp. A, J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 628, Figure 192F (1992).

Conservation status. Listed by Jones (2014) as Priority Two under Department of Parks and Wildlife Conservation Codes for Western Australian Flora.

Notes. While recognised as a distinct taxon by Wheeler (1992), it was incorrectly included in *Sa. trachyspermus* by Hunter and Bruhl (1997b) and will soon be described as a new species of *Synostemon* (Telford *et al.*, in prep). It has been maintained as a distinct taxon on *FloraBase* (Western Australian Herbarium 1998–).

Sauropus sp. **Woolgorong (M. Officer s.n. 10/8/94)**, Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Conservation status. This taxon was listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, but has recently been downgraded to Priority Three (see notes under *Sy. ramosissimus* below).

Notes. *Sauropus* sp. Woolgorong is to be described as a new subspecies of *Sy. ramosissimus*, encompassing all collections from Western Australia (Telford *et al.*, unpubl. data; see below). It will remain listed on *FloraBase* under this phrase name until it is formally described.

Synostemon F.Muell.

Synostemon glaucus F.Muell., *Fragm.* 1: 33 (1858); *Phyllanthus glaucus* (F.Muell.) Baill., *Adansonia* 6: 343 (1866), *nom. illeg. non* Wall. ex Müll.Arg. (1863); *Sauropus glaucus* (F.Muell.) Airy Shaw, *Kew Bull.* 35(3): 676 (1980). *Type citation*: 'In planitiebus collibusque siccis terrae Arnhem's Land, e.g. prope MacAdam Range, Point Pearce et Providence Hill'. *Type*: 'Dry plains toward M'Adam [McAdam] Range; Between Point Pearce and M'Adam [McAdam] Range', [Northern Territory,] Oct. 1855, *F. Mueller s.n.* (*lecto, here designated*: MEL 1594263, branchlet with female flowers and fruit attached; ?*isolecto*: G-DC G00325159, GH 00048818, K 001081103).

Phyllanthus adamii Müll.Arg. in A.DC., *Prodr.* 15(2): 327 (1866); *Diasperus adamii* (Müll.Arg.) Kuntze, *Revis. Gen. Pl.* 2: 598 (1891). *Type*: as for *Synostemon glaucus* F.Muell. [Müller Argoviensis cites only 'McAdam Range' as the locality and the specimen in G-DC (G 00325159); however, as his name was replacing Baillon's illegitimate combination the type must be the same.]

Sauropus torridus J.T.Hunter & J.J.Bruhl, *Nuytsia* 11(2): 178, Figure 1D, E (1997). *Type*: 43.8 km N of Campsite on Port Warrender track, Mitchell Plateau, N Kimberley, Western Australia, 13 October 1982, *K.F. Kenneally* 8561 (*holo*: PERTH 01640771; *iso*: K). [In the protologue, the locality and collection data are erroneously given as 'Mitchell Plateau, N of Mining Camp, top of plateau, Western Australia, 18 June 1976, *K.F. Kenneally* 5092'.]

Phyllanthus sp. B, J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 624, Figures 190I, 191I (1992), *p.p.*

Phyllanthus sp. B Kimberley Flora (T.E.H. Aplin et al. 809), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Sauropus sp. Tiwi, Dunlop *et al.*, *Fl. Darwin Reg.* 2: 237, Figure 78 (1995).

[*Sauropus ochrophyllus auct. non* (Benth.) Airy Shaw: J.W. Green, *Cens. Vasc. Pl. West. Austral.*, p. 108 (1985); J.R. Wheeler in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 626, Figure 192D (1992).]

Conservation status. This species is listed by Jones (2014) as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (as *Sa. torridus*). Recent fieldwork has shown that the species is reasonably widespread and locally common in the North Kimberley and therefore it has recently been delisted (A. Jones pers. comm.).

Typification. The MEL sheet has four sprigs, two envelopes of fragments and two labels attached: 'Dry plains towards M'Adam Range. Oct. 55. Calyx luteus. Ferd. Mueller' and 'Between Point Pearce & M'Adam Range. Calyx flavus. Oct. 1855. Ferd. Mueller'. These labels are interpreted as potentially relating to two collections, made nearby, at similar times, but as all the material and both labels are on a single sheet and represent a single taxon, linking each of the elements is not possible. We here choose the single branchlet with female flowers and fruit attached as the lectotype. At least some of the additional material on the sheet is presumably part of the same gathering, as are the probable isolectotypes cited, but they cannot be matched with certainty to this branchlet or a particular label.

Notes. Hunter and Bruhl (1997b) described *Sa. torridus* as a new species from the Mitchell Plateau. Extensive field observations and additional collections from Western Australia have shown that the type specimen is part of a single somewhat morphologically variable taxon referable to the earliest name *Sy. glaucus*. Part of the concept of *P.* sp. B in Wheeler (1992) was also referrable to *Sy. glaucus*.

Synostemon hamersleyensis I.Telford & Naaykens, *Nuytsia* 25: 32, Figure 1 (2015); *Type*: north-west of Newman, Western Australia [precise locality withheld for conservation reasons], 7 November 2012, *J. Naaykens* J969 - 11 - 12 (*holo*: PERTH 08423032; *iso*: CANB, L, NE).

Sauropus sp. Koodaideri detritals (J. Naaykens & J. Hurter JH 11213), Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 15 August 2014].

Conservation status. Currently listed as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–).

Synostemon ramosissimus F.Muell., *Fragm.* 1: 33 (1858); *Sauropus ramosissimus* (F.Muell.) Airy Shaw, *Kew Bull.* 35: 682 (1980). *Type*: 'In montibus saxosis ad flumina Suttor et Mackenzie River', [Queensland,] *s. dat.*, *s. coll.* (*holo*: MEL 226731).

Notes. The typical form of *Sy. ramosissimus* does not occur in Western Australia. All Western Australian material is referable to a new taxon that is to be described as a subspecies of *Sy. ramosissimus*. The PERTH collections of this taxon are currently housed under two names, *Sa. ramosissimus* and *Sa.* sp. Woolgorong, both of which are conservation-listed (Priority Three and Priority One respectively; Jones 2014). These collections will be consolidated under *Sa.* sp. Woolgorong until such a time as the new subspecies of *Sy. ramosissimus* is named, with a revised conservation status of Priority Three (A. Jones pers. comm.).

Synostemon trachyspermus (F.Muell.) I.Telford & Pruesapan, *Blumea* 59: 89 (2014); *Phyllanthus trachyspermus* F.Muell., *Trans. Philos. Soc. Victoria* 1: 14 (1854); *Diasperus trachyspermus* (F.Muell.) Kuntze, *Revis. Gen. Pl.* 2: 601 (1891); *Glochidion trachyspermum* (F.Muell.) H.Eichler, *Suppl. Black's Fl. S. Austral.* (2nd edn), 210 (1965); *Sauropus trachyspermus* (F.Muell.) Airy Shaw, *Kew Bull.* 35: 685 (1980). *Type*: New South Wales or Victoria: junction of the Darling and Murray Rivers, *s. dat.*, *F. Mueller s.n.* (*lecto, here designated*: MEL 1594234; *isolecto*: MEL 1595661).

Typification. There are two sheets at MEL (MEL 1594234 and MEL 1595661) that appear to represent the same collection, but as the plants are mounted on separate sheets, the sheet with the most material (and considered by John Hunter in 1997 to be a holotype) is here chosen as lectotype.

Notes. This taxon, listed as *Sa. trachyspermus* in Western Australia, should be excluded from Western Australia's plant census. The name has been misapplied against *Sa. hubbardii*, *Sa. lissocarpus* and *P. rhytidospermus* (see these taxa above). Hunter and Bruhl (1997b) incorrectly included *Sa.* sp. A Kimberley Flora and *P. rhytidospermus* as synonyms (following Airy Shaw 1980).

Acknowledgements

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Five new species and a new combination in Cyperaceae from the Kimberley region of Western Australia

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Abstract

Rye, B.L., Barrett, R.L., Barrett, M.D., Bruhl, J.J., Clarke, K.L. & Wilson, K.L. Five new species and a new combination in Cyperaceae from the Kimberley region of Western Australia. *Nuytsia* 26: 167–184 (2015). Four new species of *Actinoschoenus* Benth. and one new species of *Fimbristylis* Vahl are described from the north Kimberley region of Western Australia: *A. glabrispiculus* Rye, R.L.Barrett & M.D.Barrett, *A. pentagonus* Rye, R.L.Barrett & M.D.Barrett, *A. quadricostatus* Rye, R.L.Barrett & M.D.Barrett, *A. ramosus* Rye, R.L.Barrett & M.D.Barrett, and *F. helicophylla* Rye, R.L.Barrett & M.D.Barrett. One new combination is made: *A. arthrostyloides* (W.Fitzg.) K.L.Clarke, K.L.Wilson & J.J.Bruhl. Several of these species have very restricted distributions and are of conservation concern. Two species also occur in the western Northern Territory. All of these taxa have previously been listed on Western Australia's plant census under phrase names. All species are illustrated. A revised key to species of *Actinoschoenus* in the Kimberley region is provided.

Introduction

Cyperaceae are well represented in the Kimberley region with about 17 genera and 190 species currently recorded. Several genera in the regional flora treatment by Rye (1992) contained informally named species, indicative of the extent of taxonomic uncertainties for the sedges of this region. Further collecting, field study and examination of type specimens has enabled us to establish formal names for the species of *Actinoschoenus* Benth. and one distinctive species of *Fimbristylis* Vahl.

Full descriptions for the five new species named here—*A. glabrispiculus* Rye, R.L.Barrett & M.D.Barrett, *A. pentagonus* Rye, R.L.Barrett & M.D.Barrett, *A. quadricostatus* Rye, R.L.Barrett & M.D.Barrett, *A. ramosus* Rye, R.L.Barrett & M.D.Barrett and *F. helicophylla* Rye, R.L.Barrett & M.D.Barrett—were published previously by Rye (1992) under informal names. A new combination is provided for *A. arthrostyloides* (W.Fitzg.) K.L.Clarke, K.L.Wilson & J.J.Bruhl based on *F. arthrostyloides* W.Fitzg. (Fitzgerald 1918). Four species are endemic to the Kimberley region of Western Australia, while

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two extend into the adjacent Northern Territory. All of these species have previously been known by informal phrase names in Western Australia and four of them have conservation priority (Western Australian Herbarium 1998–).

Methods

All measurements are based on dried herbarium material. Most species newly described here have been examined in the field by R.L. and M.D. Barrett. Dry leaves, culms and seeds were mounted on stubs using double-sided carbon tape with conductive carbon paint, coated with gold using an EMITECH K550X Sputter Coater and imaged at high vacuum and high voltage (15 KVa) using a Jeol JCM 6000 NeoScope bench-top Scanning Electron Microscope at Kings Park and Botanic Garden.

Photosynthetic pathway prediction was based on the 'one cell distant criterion' of Hattersley and Watson (1975) where 1) mesophyll chlorenchyma cells are not more than one chlorenchyma cell distant from the nearest vascular bundle, which predicts C_4, or 2) a count of more than one indicates C_3 status (see Bruhl *et al.* 1987 for a more detailed explanation and application to Cyperaceae). Observations here were of culm anatomy (*cf.* Bruhl *et al.* 1987; Bruhl & Wilson 2008) for two to four collections of each species of *Actinoschoenus* treated in this paper (Table 1). Hand-cut transverse sections from the rehydrated mid-third region of culms were double-stained with 0.5% acidified Astra Blue and 0.125% Basic Fuchsin in 50% ethanol for *c.* 1–2 min and 2 s respectively. Sections were rinsed between stains and mounted in 50% glycerol for photomicroscopy. Images were captured with a Nikon DS-Ri1 digital camera on a motorised Nikon Eclipse 90i microscope using the 'large image' feature of NIS Elements AR3.22.00 software to capture and stitch multiple images.

Table 1. Vouchers used for photosynthetic pathway anatomical observations in *Actinoschoenus*. Asterisked (*) specimens under *A. ramosus* are from the East Alligator River area, Northern Territory, and require further taxonomic study (see text).

***Actinoschoenus* species**	**Vouchers**
A. arthrostyloides	*C.R. Dunlop* 5238 (PERTH 01345354)
	K.F. Kenneally 9948 (PERTH 01428888)
	J. Russell-Smith 7584 *& D. Lucas* (DNA 0037927)
A. glabrispiculus	*K.F. Kenneally* 4474 (CANB 292219)
	K.F. Kenneally 4789 (PERTH 01489054)
	J.H. Willis s.n. (PERTH 01489070)
A. pentagonus	*C.R. Dunlop* 5309 (CANB 293319)
	K.F. Kenneally 11266 (PERTH 02249154)
A. quadricostatus	*G.W. Holmes s.n.* (MEL 204869)
	P.G. Wilson 11426 (PERTH 01489011)
A. ramosus	*C.R. Dunlop* 4403 (DNA 0010763)*
	C.R. Dunlop 5303 (DNA 0017460)
	R. Fensham 872 (DNA 0054914)*
	J. Russell-Smith 8423 *& J. Brock* (DNA 0055610)*

Anatomy and photosynthetic pathway

A detailed database of photosynthetic pathway in the family Cyperaceae has been developed covering almost all genera and around 25% of all species (Bruhl & Wilson 2008), including one out of about ten species of *Actinoschoenus*. All samples of *Actinoschoenus* examined in this study (Table 1) consistently exhibited a maximum cells-distant count of more than one, indicative of C_3 photosynthetic pathway (Figure 1). Bruhl *et al.* (1987) and Bruhl and Wilson (2008) assessed a variety of methods for determining whether Cyperaceae species had C_3 or C_4 photosynthetic pathways, including anatomical (using the 'one cell distant criterion'), CO_2 compensation point analyses and $\delta^{13}C$ values. Anatomical assessment accurately predicted photosynthetic pathways for all Cyperaceae, except in some species of *Eleocharis* R.Br. The results of the present anatomical study are consistent with such findings and, with 60% of species in the genus now having been studied, make it likely that all species of *Actinoschoenus* will have C_3 anatomy.

Taxonomy

Actinoschoenus Benth.

The circumscription of genera in Abildgaardieae Lye and 'Arthrostylideae' is under investigation. *Actinoschoenus* is a member of the 'Arthrostylideae' which is embedded within the tribe Abildgaardieae and sister to *Fimbristylis* (Hinchliff & Roalson 2013). *Actinoschoenus* was included in a more broadly circumscribed *Fimbristylis* by Latz (1990). Revision of the other Australian species distributed in the Northern Territory and possibly Queensland, will follow separately (Clarke *et al.*, unpubl. data). The treatment presented here is adapted from Rye (1992).

Key to *Actinoschoenus* species in the Kimberley region of Western Australia based on Rye (1992)

1. Inflorescence of 3 or more spikelets, with 2–4 primary rays and often also secondary rays each bearing 1 spikelet. Uppermost 2 glumes 4.5–5 mm long ..... **A. ramosus**

1: Inflorescence a solitary spikelet or a head of 2–7 spikelets. Uppermost 2 glumes 6–9 mm long

2. Inflorescence bracts 2–5, obvious, the basal bract longest. Culms densely hairy, with two types of hairs, most of the hairs short but some much longer ones scattered along the ridges

3. Culms obtusely 5(6)-ridged. Spikelets (1–)2–7. Upper glumes distally minutely hairy on sides as well as midvein ..... **A. arthrostyloides**

3: Culms acutely 4-ridged. Spikelets 1–3. Upper glumes appearing glabrous at 10× or with a few hairs on midvein ..... **A. quadricostatus**

2: Inflorescence bracts many, not obvious, intergrading with the glumes, the uppermost bract longest. Culms nearly glabrous to densely hairy, the hairs all short

4. Culms 0.2–0.35 mm in diam., 4-ridged. Inflorescence of 1 spikelet; bracts and glumes glabrous except for 2 basal bracts. ..... **A. glabrispiculus**

4: Culms 0.5–1.0 mm in diam., 5-ridged. Inflorescence of 3–6 spikelets; bracts and glumes densely minutely hairy. ..... **A. pentagonus**

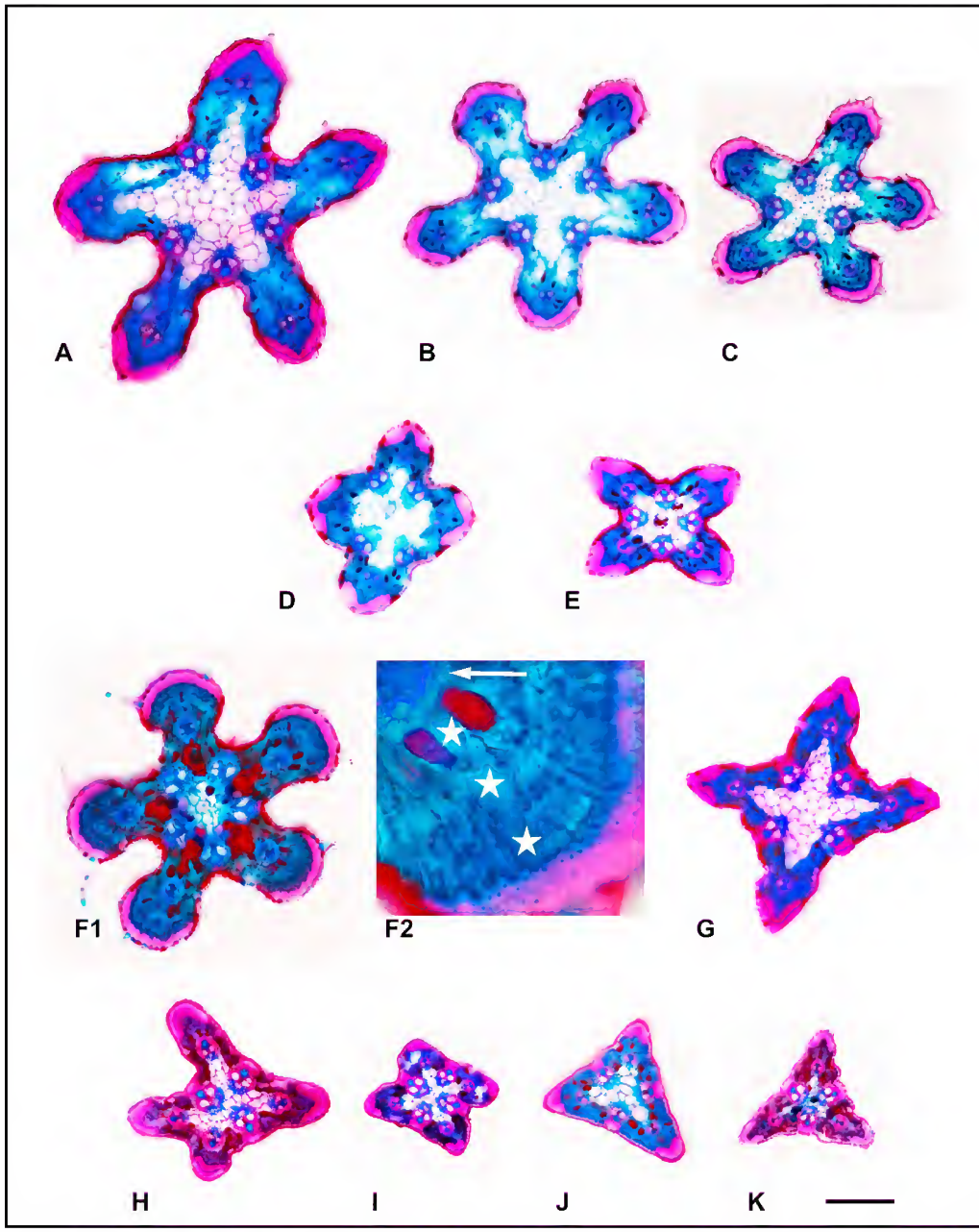

Figure 1. Astra Blue-Basic Fuchsin stained culm cross-sections of *Actinoschoenus* species showing culm features and C_3 photosynthetic pathway anatomy. A–C – *A. arthrostyloides*; D, E – *A. glabrispiculus*; F – *A. pentagonus*, showing (in F2) typical C_3 anatomy with parenchymatous bundle sheath cells without chloroplasts (arrow), and three cell layers of palisade parenchyma (i.e. a maximum cells-distant count of 2; stars); G – *A. quadricostatus*; H – *A. ramosus*; I–K – *A.* aff. *ramosus*. Scale bar = 200 µm (A–F1, G–K); 40 µm (F2). Images from *C.R. Dunlop* 5238 (A), *K.F. Kenneally* 9948 (B), *J. Russell-Smith* 7584 *& D. Lucas* (C), *K.F. Kenneally* 4474 (D), *J.H. Willis s.n.* (E), *K.F. Kenneally* 11266 (F), *P.G. Wilson* 11426 (G), *C.R. Dunlop* 5303 (H), *C.R. Dunlop* 4403 (I), *J. Russell-Smith* 8423 *& J. Brock* (J) and *R. Fensham* 872 (K). Photomicrographs by K.L. Clarke.

Actinoschoenus arthrostyloides (W.Fitzg.) K.L.Clarke, K.L.Wilson & J.J.Bruhl, *comb. nov.*

Basionym: *Fimbristylis arthrostyloides* W.Fitzg., *J. & Proc. Roy. Soc. West. Austral.* 3: 121 (1918). *Lectotype* (designated here): Artesian Range, near Walcott Inlet, Western Australia, August 1905, *W.V. Fitzgerald* 1368 (*lecto*: PERTH 01031120; *isolecto*: BM 000990865 image seen, BRI AQ0340989 image seen, NSW 696918, NSW 696919, PERTH 01031104, PERTH 01031112).

Actinoschoenus sp. B, B.L. Rye in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1037 (1992).

Actinoschoenus sp. B Kimberley Flora (G.J. Keighery 2649), G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.*, p. 41 (2000); Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Perennial, caespitose sedge, 0.3–0.8 m high. *Culms* 0.5–1 mm diam., overall shape in TS ± terete but strongly and obtusely 5(6)-ridged, densely covered by short hairs and with much longer hairs scattered along the ridges. *Leaves* densely covered by short and long hairs; uppermost leaf 35–100 mm long, with a blade 6–11 mm long. *Inflorescence* a head of (1)2–7 somewhat spreading spikelets. *Bracts* 2–5, hairy, the longest bract basal; basal bract 7–10 mm long, with a blade 6–8 mm long. *Spikelets* strongly compressed, narrowly ovate in outline, 7–9 mm long, 1.5–3 mm wide. *Glumes* 5–7, distichous, with a green keel and pale brown sides; upper glumes narrowly ovate, 6–8 mm long, distally minutely hairy, acute, often apiculate. *Stamens* 3; anther 3.5–4 mm long. *Style* undivided for 4.3–5.5 mm; base narrowly triangular to triangular in outline, *c.* 1 mm long, 0.5 mm wide; stigmatic branches 3, about as long as undivided portion of style. *Nut* with a stipe or contracted base 0.6–1 mm long; body whitish to grey-brown, 2–2.5 mm long, 1.5–2 mm wide, transversely tuberculate-ridged. C_3 photosynthetic pathway inferred from anatomy. (Figures 1A–C, 2)

Diagnostic characters. *Culms* densely hairy, displaying 2 hair types, obtusely 5(6)-ridged. *Inflorescence* (1–)2–7 spikelets; bracts 2–5, the basal bract longest. *Upper glumes* 6–8 mm long, distally minutely hairy on sides as well as midvein.

Other specimens examined. WESTERN AUSTRALIA: 9 km NNW of Mt Agnes, 9 Jan. 2001, *M.D. Barrett* MDB 1175 (NSW, PERTH); large gully, 10.8 km NE of junction of Youwanjela Creek and Prince Regent River, Prince Regent Nature Reserve, 20 Jan. 2007, *R.L. Barrett & M.D. Barrett* RLB 3670 (CANB, PERTH); Youwanjela pavement 1, 26.7 km E of Kings Cascades; 12.4 km NNE of junction of Youwanjela Creek and Prince Regent River, Prince Regent Nature Reserve, 25 Jan. 2007, *R.L. Barrett & M.D. Barrett* RLB 3840 (CANB, NSW, PERTH); HR1 Site, Harding Range, 20 km WNW of Munja, N of Walcott Inlet, 13 Jan. 2010, *R.L. Barrett, M. Maier & P. Kendrick* RLB 6008 (NE, NSW, PERTH); Cypress Valley, on W side of Morgan River, 3 km E of Theda Station Homestead, 9 Mar. 2014, *R.L. Barrett* RLB 8866 (BM, BRI, CANB, DNA, K, MEL, NE, NSW, PERTH); Mitchell River, 22 Feb. 1980, *C.R. Dunlop* 5238 (DNA, NT, PERTH); near Gariyeli Creek, Prince Regent River Reserve, 24 Aug. 1974, *A.S. George* 12594 (CANB, PERTH); overlooking AAB pitline and along last section of trapline 2, Hidden Island, Buccaneer Archipelago, 18 June 1982, *A.J.M. Hopkins* BA 0243 (PERTH); track to Mitchell Falls, Mitchell Plateau, 31 May 1988, *S.W.L. Jacobs* 5804 *& P.G. Wilson* (NSW); Surveyors Pool, Mitchell Plateau, 17 Feb. 1980, *G.J. Keighery* 2649 (PERTH); Mt Daglish vine thicket, 19 June 1987, *G.J. Keighery & J.J. Alford s.n.* (NSW, PERTH); Hunter River, W Kimberley, 26 May 1987, *K.F. Kenneally* 9948 (PERTH); Boongaree Island, Prince Frederick Harbour, 5 July 1973, *P.G. Wilson* 11374 (PERTH). NORTHERN TERRITORY: headwaters of Lalngang Creek, 16 May 1994, *I.D. Cowie* 5066 *& N.G. Walsh* (CANB, DNA, MEL *n.v.*, NT); Spirit Hills Conservation Area,

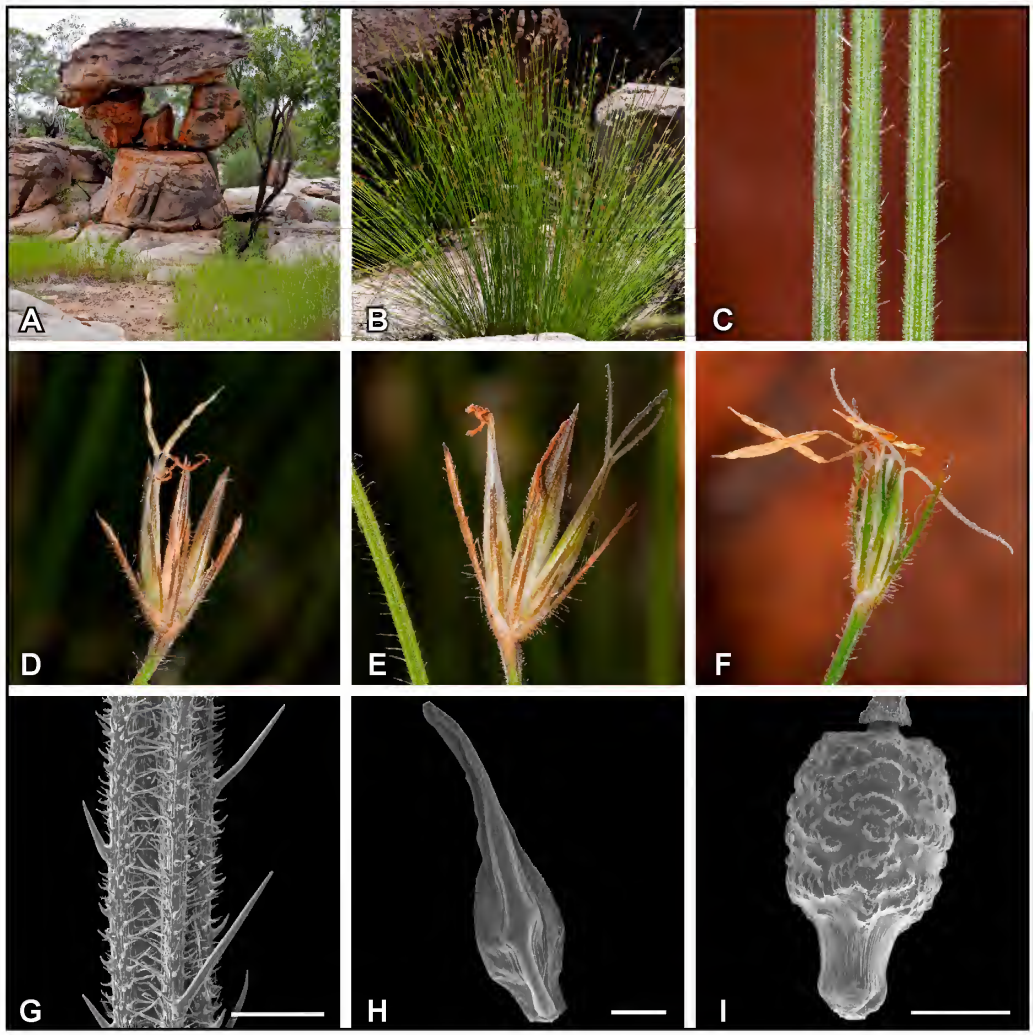

Figure 2. *Actinoschoenus arthrostyloides*. A – habitat on sand over sandstone; B – habit; C – culms; D–F – inflorescences showing anthers and/or style branches; G – SEM of culm; H – SEM of glume; I – SEM of nut. Scale bars = 500 μm (G); 1 mm (H, I). Images from *R.L. Barrett* RLB 8866 (A–F) and *R.L. Barrett* RLB 3840 (G–I). Photographs by R.L. Barrett.

Nancys Gorge, 17 Aug. 1996, *I.D. Cowie* 7114 (DNA, NSW); Keep River National Park, Spirit Hills area, *c.* 35 km SW of Bullo River Homestead, 23 Mar. 2009, *I.D. Cowie* 12307 (DNA, NSW); 44 km SE of Oenpelli, 13 June 1978, *P.K. Latz* 7764 (NT); 11 km S Legune Station, 5 Mar. 1989, *J. Russell-Smith* 7584 *& D. Lucas* (DNA); Bradshaw Military Training Area, *c.* 80 km NW Timber Creek, 2 Apr. 2007, *B.M. Stuckey & I.D. Cowie* 56 (DNA, PERTH).

Phenology. Flowers and fruits recorded in February and from May to August.

Distribution and habitat. Occurs in open woodland with shrubs on sand associated with sandstone, sometimes occurring on the edges of pools. From the Kimberley region, extending from Mitchell Plateau and Boongaree Island south to near Walcott Inlet, east to Bullo River in the Northern Territory.

Conservation status. Currently known from thirteen locations in Western Australia and six in the adjacent Northern Territory, and sufficiently widespread not to require listing as a priority species.

Etymology. The epithet is from the genus *Arthrostylis* R.Br. with the Greek termination *-oides* (like), in reference to the similar appearance of this species to that genus.

Typification. The lectotype is selected from seven duplicate sheets located by us. The primary sets of Fitzgerald's collections from names published by him in 1918 are usually duplicated at NSW and PERTH, so it is customary to choose a lectotype from one of these herbaria. The set at PERTH is stated to be the main material by Maiden (in Fitzgerald 1918), so this material is given preference. PERTH 01031120 is chosen as it contains mature material with nuts and has a label in Fitzgerald's script.

Notes. While this taxon has been known for some time to belong in *Actinoschoenus*, the relevant combination has not previously been made.

Most similar to *A. quadricostatus* and readily distinguished by the obtusely 5(6)-ridged culms (*vs* acutely 4-ridged) and (1)2–7 spikelets per head (*vs* 1–3).

The vernacular name of Hairy Actinoschoenus is suggested.

Actinoschoenus glabrispiculus Rye, R.L.Barrett & M.D.Barrett, *sp. nov.*

Type: west of Drysdale River, Drysdale River National Park, Western Australia [precise locality withheld for conservation reasons], 29 April 2008, *R.L. Barrett & M.D. Barrett* RLB 4895 (*holo*: PERTH 08046808; *iso*: CANB, DNA, K, NE, NSW).

Actinoschoenus sp. D, B.L. Rye in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1039, Figure 310C (1992).

Actinoschoenus sp. D Kimberley Flora (K.F. Kenneally 4789), G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.*, p. 41 (2000); Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Illustration. B.L. Rye in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1038, Figure 310C (1992) [as *Actinoschoenus* sp. D].

Perennial, caespitose sedge, 0.3–0.6 m high. *Culms* 0.2–0.3 mm diam, obtusely 4-ridged, shortly hairy throughout or glabrescent especially along the ridges. *Leaves* densely shortly hairy to partially glabrous; uppermost leaf 30–40 mm long, with a blade up to 3 mm long. *Inflorescence* of 1 spikelet. *Bracts* 2–many but not clearly differentiated from the glumes, gradually increasing in size from base upwards; basal bracts 2–2.5 mm long, with a point or short blade 0.5–1 mm long, slightly hairy; upper bracts glabrous. *Spikelet* narrowly ovoid, 9–11 mm long, 1–2 mm diam. *Glumes* (and all but basal 2 inflorescence bracts) 10–12, 4-ranked or nearly so, with a green keel and whitish sides, becoming medium brown, glabrous; upper glumes narrowly ovate, 7–9 mm long, apiculate. *Stamens* 3; anther not seen. *Style* undivided for *c.* 7.3 mm; base narrowly triangular in outline, *c.* 1 mm long, 0.5 mm wide; stigmatic branches 3, apparently shorter than undivided part. *Nut* with a stipe or contracted base 1–1.6 mm long; body whitish to grey-brown, 2–2.5 mm long, 1.4–1.8 mm wide, transversely tuberculate-rugose or somewhat tuberculate-ridged. C_3 photosynthetic pathway inferred from anatomy. (Figures 1D, E, 3)

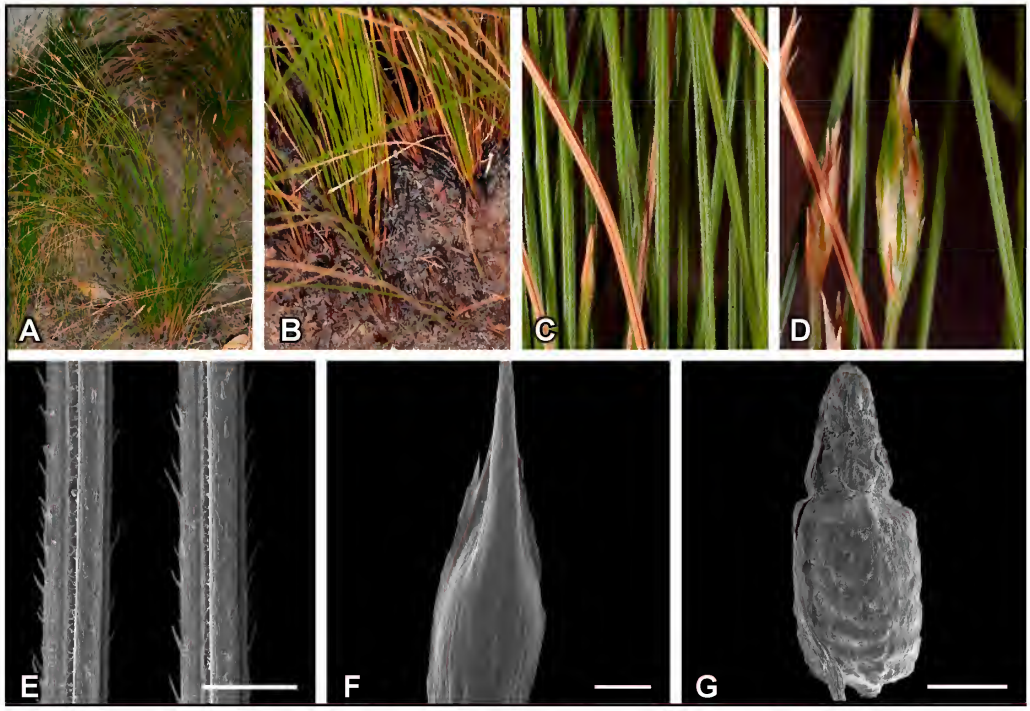

Figure 3. *Actinoschoenus glabrispiculus*. A – habit; B – compact plant base resprouting following fire; C – culms; D – inflorescence; E – SEM of culm; F – SEM of glume; G – SEM of nut. Scale bars = 500 μm (E); 1 mm (F, G). Images from *R.L. Barrett & M.D. Barrett* RLB 4895. Photographs by R.L. Barrett.

Diagnostic characters. *Culms* 0.2–0.3 mm diam., 4-ridged, nearly glabrous to densely hairy, the hairs all short. *Inflorescence* of 1 spikelet; bracts many or intergrading with the glumes, the uppermost bract longest; glabrous except for 2 basal bracts. *Upper glumes* 7–9 mm long, glabrous.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 22 May 1984, *E.A. Chesterfield, S.J. Forbes & J.H. Willis* EAC 319 (CANB, K *n.v.*, L *n.v.*, MO *n.v.*, NSW, NT, PERTH); 19 May 2003, *K. Coate* 676 (PERTH); 22 Feb. 1980, *C.R. Dunlop* 5239 (DNA, NT, PERTH); 19 Aug. 1975, *K.F. Kenneally* 4474 (CANB, NT, PERTH); 13 June 1976, *K.F. Kenneally* 4789 (NT, PERTH 4 sheets); 28 May 1987, *K.F. Kenneally* 10017 (PERTH); 10 May 1986, *P.K. Latz* 10290 (DNA, NSW, NT); 11 Aug. 2008, *C. Sgherza* 8 (PERTH); 22 May 1984, *J.H. Willis s.n.* (MEL *n.v.*, NSW, NT, PERTH).

Phenology. Flowers and fruits recorded in February and from May to August.

Distribution and habitat. Occurs on sandstone in open woodland and shrubland. Endemic to the Kimberley region, extending from Bigge Island and the Mitchell Plateau east to Napier Broome Bay and Drysdale River National Park.

Conservation status. *Actinoschoenus glabrispiculus* is listed by Jones (2014) as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *A.* sp. D Kimberley Flora (K.F. Kenneally 4789). Known from nine collections from four broad locations in the north-west Kimberley. Probably more widespread but poorly collected.

Etymology. The epithet is from the Latin *glabri-* (glabrous-) and *spicula* (spikelet), in reference to the glabrous spikelets in this species.

Notes. Most similar to *A. pentagonus* and readily distinguished by the inflorescence having only a single spikelet (*vs* 3–6), 4-ridged culms (*vs* 5-ridged), and glabrous upper bracts and glumes (*vs* densely minutely hairy).

The vernacular name of Smooth Actinoschoenus is suggested.

Actinoschoenus pentagonus Rye, R.L.Barrett & M.D.Barrett, *sp. nov.*

Type: Carson Escarpment, 41 km south-east of new Theda Station Homestead, Drysdale River National Park, Western Australia, 29 April 2008, *R.L. Barrett & M.D. Barrett* RLB 4890 (*holo*: PERTH 08046727; *iso*: NE, NSW).

Actinoschoenus sp. E, B.L. Rye in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1039, Figure 310D (1992).

Actinoschoenus sp. E Kimberley Flora (C.R. Dunlop 5309), G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.*, p. 41 (2000); Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Illustration. B.L. Rye in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1038, Figure 310D (1992) [as *Actinoschoenus* sp. E].

Perennial, caespitose sedge, 0.4–1 m high. *Culms* 0.5–0.8 mm diam., obtusely 5-ridged (rarely a few culms 4-ridged), densely shortly hairy throughout or glabrescent especially on the ridges. *Leaves* densely hairy; uppermost leaf 35–70 mm long, the blade 2–5 mm long. *Inflorescence* of 3–6 scarcely spreading spikelets, often resembling a solitary spikelet. *Bracts* many, greenish, gradually increasing in size from base upwards, densely shortly hairy; basal bract 3–5 mm long; uppermost bract *c.* 6 mm long, with a point or short blade up to 1.7 mm long. *Spikelets* compressed, narrowly ovate in outline, 7–11 mm long, *c.* 2 mm wide. *Glumes* 4–6, distichous to almost spirally arranged, pale to medium brown, densely minutely hairy; uppermost glumes narrowly ovate, 7–9 mm long, acute, often apiculate. *Stamens* 3; anther *c.* 4 mm long. *Style* undivided for 5.3–7 mm; base triangular or narrowly triangular in outline, 0.8–1.5 mm long, 0.5–0.8 mm wide; stigmatic branches 3, about as long as or somewhat longer than remainder of style. *Nut* with a stipe or basal contraction 0.8–1.5 mm long; body whitish or pale brown, *c.* 3 mm long, 1.6–2 mm wide, smooth to slightly tuberculate-rugose between the angles. C_3 photosynthetic pathway inferred from anatomy. (Figures 1F, 4)

Diagnostic characters. *Culms* 0.5–0.8 mm diam., 5-ridged, nearly glabrous to densely hairy, the hairs all short. *Inflorescence* of 3–6 spikelets; bracts many or intergrading with the glumes, the uppermost bract longest; minutely hairy. *Uppermost glumes* 7–9 mm long, densely minutely hairy.

Other specimens examined. WESTERN AUSTRALIA: near creek on Kalumburu road, 174.4 km by road N from junction with Gibb River to Ellenbrae road, 30 Apr. 1985, *T.E.H. Aplin et al.* 817 (PERTH); *c.* 10 km E of Purulba Massif, Prince Regent Nature Reserve, 2 Feb. 1999, *M.D. Barrett* 710 (PERTH); 6.7 km NE of Bachsten Creek campsite, Prince Regent Nature Reserve, 3 Feb. 1999, *M.D. Barrett* 747 (PERTH); Roe River [pavement 1] on mainland, 3 km ESE of Gertrude Cove, Kiska Island, 23 Apr. 2008, *R.L. Barrett & M.D. Barrett* RLB 4597 (PERTH); HR1 Site, Harding Range,

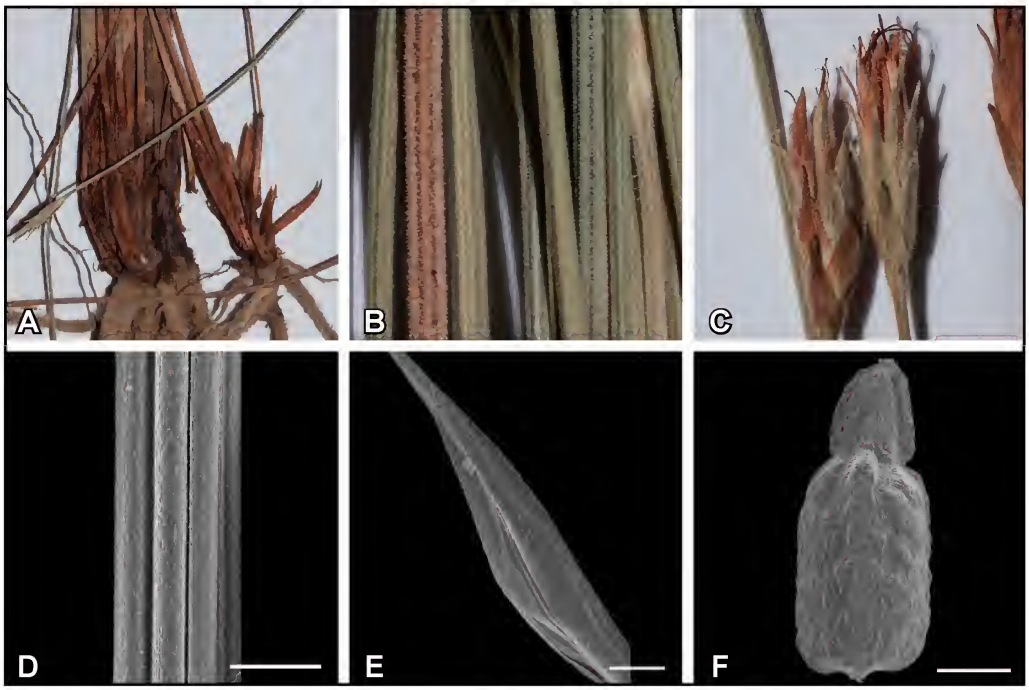

Figure 4. *Actinoschoenus pentagonus*. A – plant base with sand-binding roots; B – culms; C – inflorescence; D – SEM of culm; E – SEM of glume; F – SEM of nut. Scale bars = 500 μm (D); 1 mm (E, F). Images from *R.L. Barrett & M.D. Barrett* RLB 4597 (A–C) and *R.L. Barrett & M.D. Barrett* RLB 3776 (D–E). Photographs by R.L. Barrett.

20 km WNW of Munja, N of Walcott Inlet, 13 Jan. 2010, *R.L. Barrett, M. Maier & P. Kendrick* RLB 6009 (BRI, CANB, MEL, NE, NSW, PERTH); Governor Island, Napier Broome Bay, 19 May 1986, *E.A. Chesterfield, S.J. Forbes & J.H. Willis* EAC 247 (MEL, NSW, NT *n.v.*, PERTH); Mitchell Plateau, 26 Feb. 1980, *C.R. Dunlop* 5309 [distributed as 5306] (BRI *n.v.*, CANB, DNA, K *n.v.*, NSW, NT *n.v.*, PERTH); *c.* 1.4 km S of Ila Point, West Governor Island, Napier Broome Bay, 19 May 1984, *S.J. Forbes* 2061 (MEL *n.v.*, NT *n.v.*, PERTH); base of Anjo Peninsula (between Napier Broome Bay and Vansittart Bay), 5 km N of West Bay landing, 22 May 1984, *S.J. Forbes* 2114 (CANB, L *n.v.*, MEL, NSW, NT *n.v.*, PERTH); Blyxa Creek, Prince Regent River Reserve, 19 Aug. 1974, *A.S. George* 12454 (NT *n.v.*, PERTH 2 sheets); Mertens Creek, Mitchell Plateau, 31 May 1988, *S.W.L. Jacobs & Peter G. Wilson* SWLJ 5813 (DNA *n.v.*, NSW, PERTH); adjacent to King George River above Falls, 7 June 1992, *K.F. Kenneally* 11266 (NSW, PERTH); Mitchell Falls walking track, Mitchell Plateau, 20 July 1988, *M. Parris* 9392 (CANB, PERTH); *c.* 1 km SW of Mitchell Plateau track on western side of King Edward River crossing, 2 July 2002, *K.L. Wilson* 10096 (EIU, GENT, NSW, NY, PERTH, PRE); 6 km N of Kalumburu on Pago road, 3 July 2002, *K.L. Wilson* 10103 (NE, NSW, PERTH); parking area at start of path to Mitchell Falls, 1 July 2002, *K.L. Wilson* 10092 (L, NSW, PERTH). NORTHERN TERRITORY: Keep River National Park, Spirit Hills section, 10 May 2008, *I.D. Cowie* 12099 (B *n.v.*, DNA *n.v.*, MO *n.v.*, NSW); Spirit Hills section, Keep River National Park, 10 May 2008, *I.D. Cowie* 12104 (DNA *n.v.*, NSW, PERTH); *c.* 19 km NNW of Bullo River homestead, Spirit Hills, Keep River National Park, 22 Mar. 2009, *I.D. Cowie* 12291 (DNA *n.v.*, MO *n.v.*, NSW, PERTH); Spirit Hills Conservation Reserve, *c.* 100 km N of Ranger Station, 13 May 2011, *D.L. Lewis* 1720 (CANB, DNA *n.v.*, NSW).

Phenology. Flowers and fruits from February to May, also recorded in August.

Distribution and habitat. Grows in sand or gravelly soil on sandstone in open woodland with *Triodia* spp. From the north Kimberley region, between Mitchell Plateau, Prince Regent River Reserve, Governor Island and King Edward River, and just into the western Northern Territory near Keep River.

Conservation status. *Actinoschoenus pentagonus* appears to be widespread and is not currently threatened.

Etymology. The epithet is from the Greek *penta-* (five-) and *-gonus* (angled), in reference to the five-ridged culms in this species.

Notes. The base of the plant seems to be more resinous than in the other species of *Actinoschoenus* described here. Because the spikelets are closely associated and the inflorescence bracts are numerous, the head can easily be mistaken for a single spikelet.

Actinoschoenus pentagonus appears to be similar to the species referred to as *Fimbristylis* sp. G in Latz (1990) [= *A.* sp. Mount Brockman (R.C. Hinz 362); CHAH 2007–] but with fewer culm ribs (5 *vs* 5–9), larger spikelets (7–11 *vs* 4.5–7 mm long) and fewer of them per head (3–6 *vs* 3–10 per head). It is most similar to *A. glabrispiculus* and readily distinguished by the inflorescence having 3–6 spikelets (*vs* solitary), 5-ridged culms (*vs* 4-ridged), and densely minutely hairy upper bracts and glumes (*vs* glabrous).

There appear to be two variants of this species, the typical variant with densely hairy culms (Figure 4B), and a second variant with glabrous to sparsely hairy culms (e.g. *R.L. Barrett & M.D. Barrett* RLB 3776; Figure 4D). Further investigation is required to determine whether there are other differences that may justify the recognition of two taxa.

The vernacular name of Five-angled Actinoschoenus is suggested.

Actinoschoenus quadricostatus Rye, R.L.Barrett & M.D.Barrett, *sp. nov.*

Type: Uwins Island, Bonaparte Archipelago, Western Australia [precise locality withheld for conservation reasons], 6 June 2008, *M.N. Lyons* 6020 (*holo*: PERTH 08615497; *iso*: CANB, NE, NSW).

Actinoschoenus sp. C, B.L. Rye in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1037, Figure 310B (1992).

Actinoschoenus sp. C Kimberley Flora (P.G. Wilson s.n. 12/5/72), G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.*, p. 41 (2000); Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Illustration. B.L. Rye in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1038, Figure 310B (1992) [as *Actinoschoenus* sp. C].

Perennial, caespitose sedge, 0.2–0.6 m high. *Culms* 0.5–0.75 mm diam., acutely 4-ridged, densely shortly hairy and with scattered much longer hairs to 0.6 mm long. *Leaves* densely covered by short and long hairs; uppermost leaf 25–65 mm long, with a blade 6–10 mm long. *Inflorescence* of 1 spikelet or a head of 2 or 3 somewhat spreading spikelets. *Bracts* 2 or 3, hairy, the longest bract basal; basal bract 6–10 mm long, with a blade 5–8 mm long. *Spikelets* strongly compressed, narrowly ovate in outline, 7–9 mm long, 1.5–3 mm wide. *Glumes* 4–6, distichous, with a green keel and brown sides;

upper glumes narrowly ovate, 6–8 mm long, glabrous or with a few hairs on midvein, apiculate. *Stamens* 3; anther not seen. *Style* undivided for 5–6 mm; base narrowly triangular in outline, 1.5–2 mm long, *c.* 0.5 mm wide; stigmatic branches 3, about as long as remainder of style. *Nut* with a stipe or contracted base 0.7–1 mm long; body 2.2–2.5 mm long, 1.8–2 mm wide, transversely tuberculate-ridged. C_3 photosynthetic pathway inferred from anatomy. (Figures 1G, 5)

Diagnostic characters. *Culms* acutely 4-ridged, densely hairy, most of the hairs short but some much longer ones scattered along the ridges. *Inflorescence* of 1–3 spikelets; bracts 2 or 3, the basal bract longest. *Upper glumes* 6–8 mm long, glabrous or with a few hairs on midvein.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] May 1943, *Rev. G.W. Holmes s.n.* (MEL, PERTH); 13 Feb. 2009, *G.J. Keighery s.n.* (NSW, PERTH); 8 June 2008, *M.N. Lyons* 6068 (PERTH); 12 May 1972, *P.G. Wilson s.n.* (PERTH); 7 July 1973, *P.G. Wilson* 11426 (PERTH).

Phenology. Flowers and fruits from February to July.

Distribution and habitat. Recorded in woodland, sometimes associated with pools on sandstone. Endemic to the Kimberley region and known only from the Bonaparte Archipelago on Augustus Island, Uwins Island, St Andrews Island (Lyons *et al.* 2013) and the adjacent mainland near Kunmunya Hill.

Conservation status. *Actinoschoenus quadricostatus* is listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *A.* sp. C Kimberley Flora (P.G. Wilson s.n. 12/5/72).

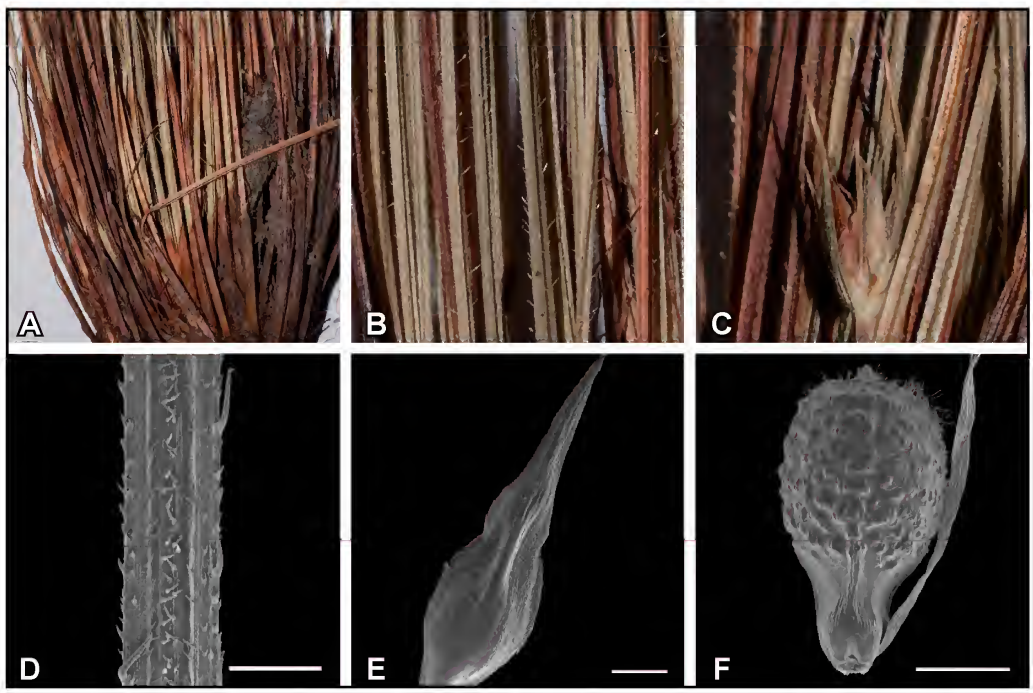

Figure 5. *Actinoschoenus quadricostatus*. A – plant base; B – culms; C – inflorescence; D – SEM of culm; E – SEM of glume; F – SEM of nut. Scale bars = 500 μm (D); 1 mm (E, F). Images from *M.N. Lyons* 6020. Photographs by R.L. Barrett.

Etymology. The epithet is from the Latin *quadri-* (four-) and *costatus* (ribbed), in reference to the four-ribbed culms.

Notes. Morphologically similar to *A. arthrostyloides* but differing in having very slender, 4-ribbed culms (*vs* 5(6)-ridged), 1–3 spikelets per head (*vs* (1)2–7), and with upper glumes glabrous or nearly so (*vs* minutely hairy distally on sides and midvein).

The vernacular name of Four-ribbed Actinoschoenus is suggested.

Actinoschoenus ramosus Rye, R.L.Barrett & M.D.Barrett, *sp. nov.*

Type: upper Lawley River, Lawley River National Park, Western Australia [precise locality withheld for conservation reasons], 12 March 2014, *R.L. Barrett* RLB 8988 (*holo*: PERTH 08614911; *iso*: BRI, DNA, K, NE, NSW).

Actinoschoenus sp. A, B.L. Rye in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1037, Figure 310A (1992).

Actinoschoenus sp. A Kimberley Flora (C.R. Dunlop 5303), G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.*, p. 41 (2000); Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Illustration. B.L. Rye in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1038, Figure 310A (1992) [as *Actinoschoenus* sp. A].

Perennial, caespitose sedge, 0.3–0.6 m high. *Culms* 0.3–0.4 mm diam., lax, obtusely 3- or 4-ridged, scabridulous immediately below inflorescence, elsewhere glabrous or nearly so. *Leaves* usually with short hairs on blade and orifice of sheath, glabrous or slightly shortly hairy below; uppermost leaf 45–85 mm long, with a blade 1–7 mm long. *Inflorescence* a loose simple or compound arrangement of 3 or more spikelets, the peduncle and each ray bearing 1 spikelet; primary rays 2–4, 3–8 mm long; secondary rays 0–2. *Bracts* 2 or 3, ciliate to almost glabrous on sheath, shortly hairy on blade, the longest bract basal, the basal bract 4–7 mm long, with a blade 3–5 mm long. *Spikelets* not very compressed, narrowly ovate in outline, 5.5–7 mm long, 1–1.5 mm wide. *Glumes c.* 6, 4-ranked to slightly spirally arranged, green on keel and ferruginous on sides, glabrous; upper glumes narrowly ovate, 4.5–5 mm long, usually slightly apiculate. *Stamens* 3; anther 3–4 mm long. *Style* undivided for 2–4 mm; base triangular in outline, *c.* 0.5 mm long, *c.* 0.3 mm wide; stigmatic branches 3, about as long as or longer than remainder of style. *Nut* with a stipe or basal contraction 0.3–0.5 mm long; body whitish, 1.3–1.4 mm long, 0.9–1.1 mm wide, transversely tuberculate-ridged. C_3 photosynthetic pathway inferred from anatomy. (Figures 1H, 6)

Diagnostic characters. *Inflorescence* of 3 or more spikelets, with 2–4 primary rays and often also secondary rays, each bearing 1 spikelet, the basal bract longest. *Upper glumes* 4.5–5 mm long.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 25 Jan. 2007, *R.L. Barrett & M.D. Barrett* RLB 3860 (K, NSW, PERTH); 25 Jan. 2007, *R.L. Barrett & M.D. Barrett* RLB 3955 A (NSW, PERTH); 22 Apr. 2008, *R.L. Barrett & M.D. Barrett* RLB 4529 (PERTH); 15 Jan. 2010, *R.L. Barrett & M. Maier* RLB 6046 (NE, NSW, PERTH); 19 Jan. 2010, *R.L. Barrett, M. Maier & P. Kendrick* RLB 6263 (CANB, PERTH); 25 Jan. 2010, *R.L. Barrett & M.D. Barrett* RLB 6431 (PERTH); 24 Feb. 1980, *C.R. Dunlop* 5303 (BRI, *n.v.*, CANB, DNA, NSW, NT, PERTH); 19 Jan. 1982, *K.F. Kenneally* 7796 (NSW, PERTH).

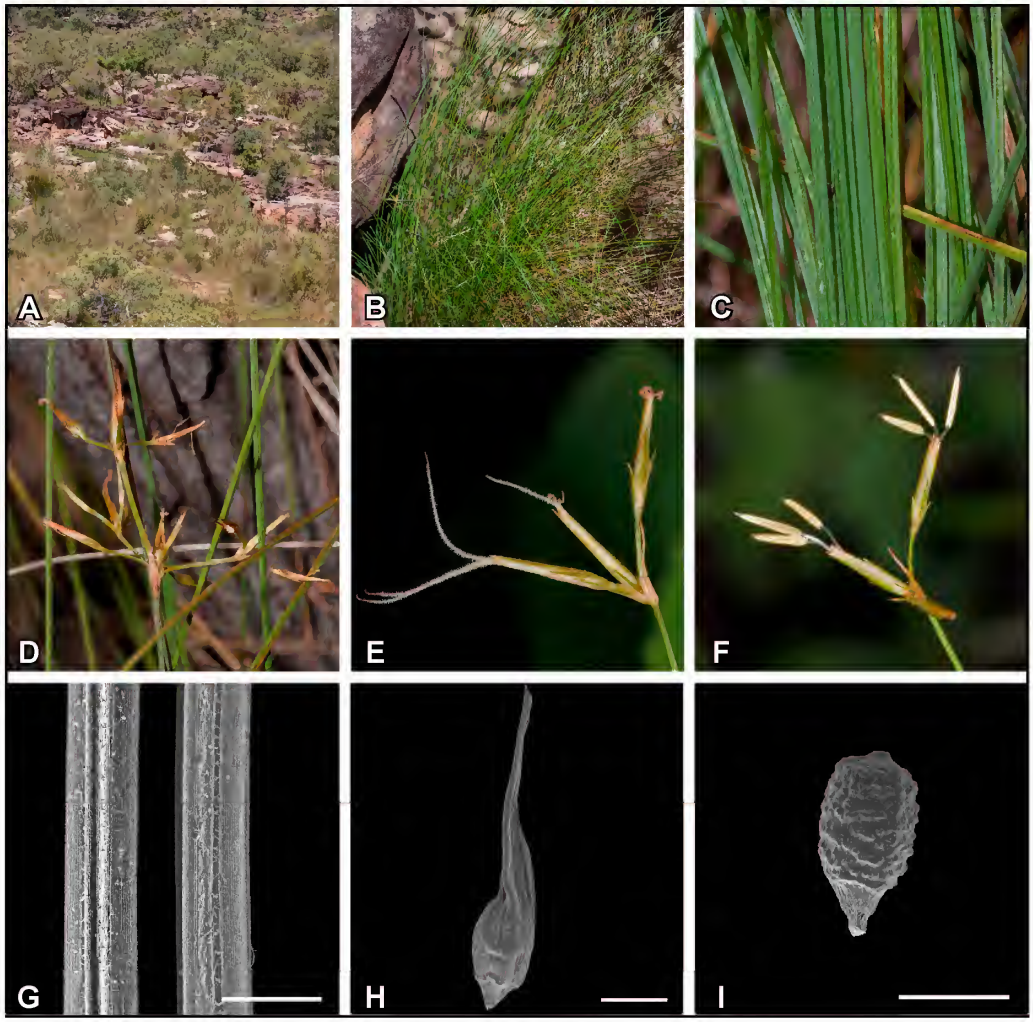

Figure 6. *Actinoschoenus ramosus*. A – habitat on sand over broken sandstone; B – lax habit; C – culms; D – openly branching inflorescence; E – spikelets showing style branches; F – spikelets showing anthers; G – SEM of culm; H – SEM of glume; I – SEM of nut. Scale bars = 500 μm (G); 1 mm (H, I). Images from *R.L. Barrett* RLB 8988 (A–F) and *R.L. Barrett* RLB 3860 (G–I). Photographs by R.L. Barrett.

Phenology. Flowers and fruits recorded from January to February.

Distribution and habitat. Apparently endemic to the Kimberley region where it is known between the Lawley River, Mitchell Plateau and the Prince Regent River. Recorded in sand amongst sandstone rocks or in skeletal sand on sandstone in open woodland, often between boulders that offer a degree of shading; one record is 'adjacent to a watercourse'.

Conservation status. Recently listed as Priority Three under Department of Parks and Wildlife Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–) under the name *A*. sp. A Kimberley Flora (C.R. Dunlop 5303).

Etymology. The epithet is from the Latin *ramosus* (branched) in reference to the openly branched inflorescence.

Notes. The morphology of *A. ramosus* is very distinct and it is easily separated from all other named species in the genus by the openly branched inflorescence, the other species all having spikelets more or less sessile in a head.

Collections from the vicinity of the East Alligator River, Northern Territory (e.g. *C.R. Dunlop* 4403; *R. Fensham* 872; *J. Russell-Smith* 8423 *& J. Brock*) known by the phrase name *Fimbristylis* sp. Deaf Adder Gorge (C.R. Dunlop 4403) at DNA are evidently very closely related to *A. ramosus*. Indeed, the DNA duplicate of *C.R. Dunlop* 5303 (the voucher specimen for *A.* sp. A Kimberley Flora, upon which *A. ramosus* is based), is determined there as *F.* sp. Deaf Adder Gorge, highlighting their close similarity. While specimens from both states are very similar in general appearance, the Northern Territory collections have smaller spikelets and fruits, and thinner, 3(4)-ribbed culms relative to the thicker, (3)4-ribbed culms of the Western Australian collections seen. The culm differences are illustrated in Figure 1H–K. The differences in spikelet, fruit and culm size may represent clinal variation within a single taxon or *F.* sp. Deaf Adder Gorge may be a distinct taxon; further study of *F.* sp. Deaf Adder Gorge is underway by one of us (KLC) and it is retained as separate here pending the outcome of that study.

The vernacular name of Soft Actinoschoenus is suggested.

Fimbristylis Vahl

Fimbristylis helicophylla Rye, R.L.Barrett & M.D.Barrett, *sp. nov.*

Type: east of Theda Station Homestead, Western Australia [precise locality withheld for conservation reasons], 11 March 2014, *R.L. Barrett* RLB 8945 (*holo*: PERTH 08614881; *iso*: BM, BRI, CANB, DNA, GENT, MEL, NE, NSW, NY, PERTH).

Fimbristylis sp. G, B.L. Rye in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1093, Figure 317R (1992).

Fimbristylis sp. G Kimberley Flora (A.C. Beauglehole 51810), G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.*, p. 49 (2000); Western Australian Herbarium, in *FloraBase*, http://florabase.dpaw.wa.gov.au/ [accessed 1 March 2014].

Illustration. B.L. Rye in J.R. Wheeler (ed.), *Fl. Kimberley Reg.*, p. 1076, Figure 317R (1992) [as *Fimbristylis* sp. G].

Perennial tufted sedge, 0.35–0.60 m high, with a short rhizome. *Culms* 1.0–1.4 mm wide, striate, glabrous. *Lowest leaves* initially distichous, usually 5–17 cm long, the sheath green to pale brown to dark red-brown, almost glabrous with just a few ciliate hairs at the apex, the blade 2.0–3.6 mm wide, twisted along its length, glabrous, or with scattered ciliate hairs on margins, margins pale, thickened. *Culm-sheathing leaves* 1 or 2 per culm, reduced to sheath, almost glabrous with just a few ciliate hairs at the membranous apex, 8.5–12 cm long. *Inflorescence* a cyme or compound cyme, with a central sessile spikelet and 1–4 pedunculate lateral spikelets; primary rays 1–3, erect to spreading, 15–30 mm long. *Bracts* usually 2, reduced to sheath, rather glume-like, with broad, membranous margins reaching apex, ciliate, the basal bract 5.3–6.2 mm long. *Spikelets* pale brown, ovoid or narrowly obloid-ellipsoid to almost globular, 6.2–10.4(–12.1) mm long, 3.1–6.1 mm diam., many-flowered, obtuse; axis not prominently winged. *Glumes* spirally arranged, with a prominent green and red-brown keel and red-brown-spotted, broad, membranous margins, oblong-elliptic to almost circular, 4–5 mm long, ciliate,

emarginate. *Stamens* 3; filament white, 4–6 mm long, anther 2.0–2.3 mm long. *Style* triquetrous, glabrous except on base or slightly scabridulous on angles, undivided for *c.* 3 mm; base prominently enlarged, triangular to broadly triangular in outline, 0.3–0.4 mm wide, ciliate on each angle and with larger, patent to retrorse hairs at base, the largest *c.* 0.4 mm long; stigmatic branches 3, shorter than remainder of style. *Nut* very shortly stipitate, brown to black, trigonous with convex faces, subterete, broadly obovate in outline, 0.8–1.0 mm long, 0.7–0.8 mm wide, tuberculate. (Figure 7)

Diagnostic characters. *Perennial* sedge. *Culms* 1.0–1.4 mm wide, striate. *Leaves* with blade 2.0–3.6 mm wide, twisted along its length, margins pale, thickened. *Inflorescence* a cyme or compound cyme, with a central sessile spikelet and 1–4 pedunculate lateral spikelets. *Spikelets* ovoid to almost globular, 6.2–10.4(–12.1) mm long. *Glumes* spirally arranged, with red-brown-spotted, broad, membranous margins, 4–5 mm long, ciliate. *Nut* trigonous, 0.8–1.0 mm long, 0.7–0.8 mm wide, tuberculate.

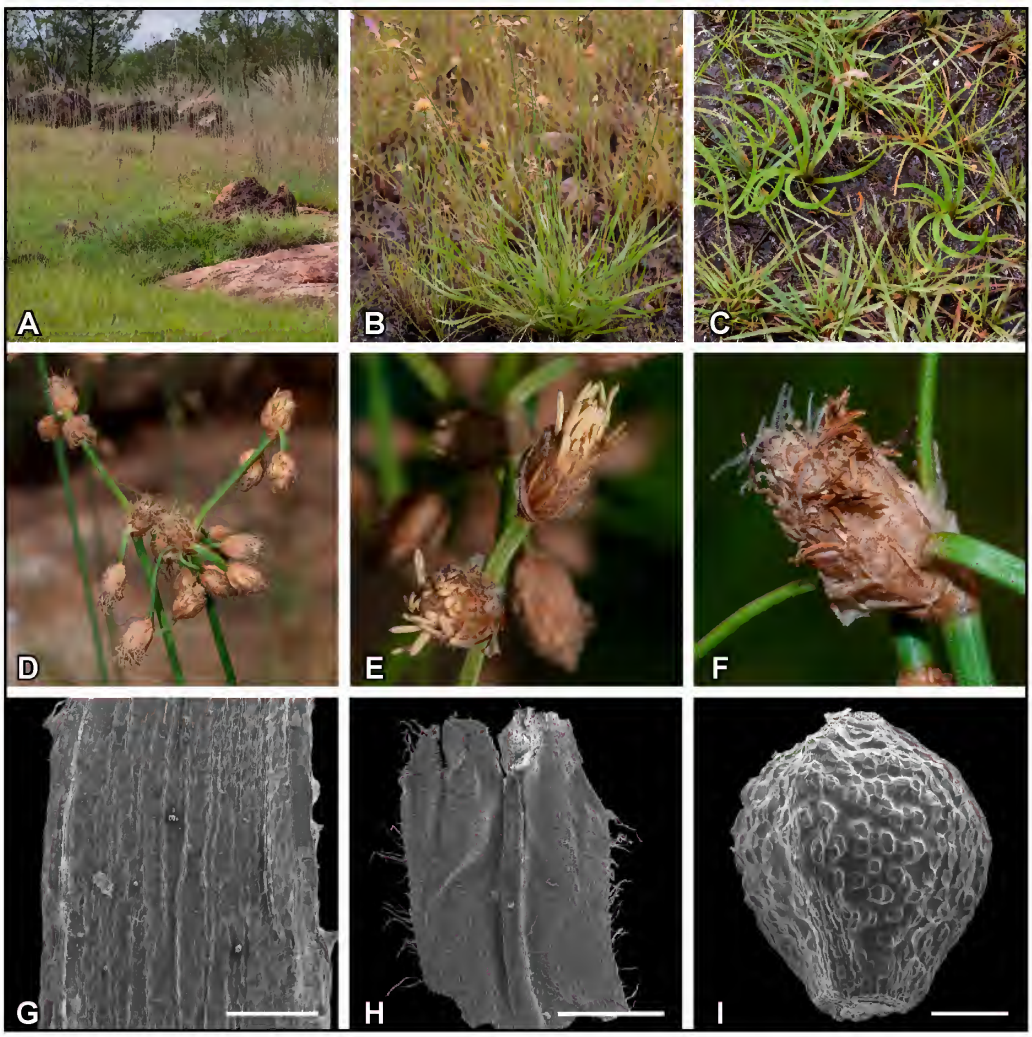

Figure 7. *Fimbristylis helicophylla*. A – habitat, B – habit, C – leafy rosettes with twisted leaves; D – branched inflorescence; E – spikelets showing anthers; F – spikelet showing style branches; G – SEM of leaf; H – SEM of glume; I – SEM of nut. Scale bars = 500 μm (G), 1 mm (H), 200 μm (I). Images from *R.L. Barrett* RLB 8945. Photographs by R.L. Barrett.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 22 Feb. 2005, *M.D. Barrett* MDB 1643 B (PERTH); 25 Mar. 2010, *M.D. Barrett & R.L. Barrett* MDB 2781 (PERTH); 4 Dec. 1994, *R.L. Barrett & M.D. Barrett* RLB 1009 (PERTH); 16 Feb. 2006, *R.L. Barrett & M.D. Barrett* RLB 3117 (NE, NSW, PERTH); 6 June 2012, *R.L. Barrett* RLB 7687 (DNA, NE, NSW, PERTH); 31 May 1976, *A.C. Beauglehole* 51810 (NT, PERTH).

Phenology. Flowers and fruits recorded for March to June.

Distribution and habitat. Possibly endemic to the Kimberley region, known from Theda and Doongan Stations on the Kalumburu–Gibb River road, and south to Prince Regent National Park and the Harding Range.

Conservation status. *Fimbristylis helicophylla* is listed by Jones (2014) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora under the name *F.* sp. G Kimberley Flora (A.C. Beauglehole 51810).

Etymology. The epithet is from the Greek *helicus* (spirally twisted) and *-phyllus* (leaved), in reference to the leaves of this species which are distinctly twisted along their length.

Notes. Superficially similar to *F. lanceolata* C.B.Clarke, with which it grows on Theda Station, in having broad leaves, but readily distinguished when fertile by the relatively short, ovoid to almost globular spikelets (6.2–10.4(–12.1) vs 10–35 mm long) with pale brown glumes (vs mid-brown). *Fimbristylis helicophylla* has broad spikelets on rather curved branches like *F. rara* R.Br. and similar species placed in sect. *Leptocladae* Ohwi by Kern (1974). *Fimbristylis rara* is an annual with mid-brown (vs pale brown) spikelets, which are often shorter (2.5–7(–13) vs 6.2–10.4(–12.1) mm long). The broad, twisted leaves of *F. helicophylla* are unusual in this section.

The vernacular name of Twisted Leaf Fimbristylis is recommended.

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Referees for Volume 26

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Tony Bean
Robert Davis
Alex George
Ailsa Holland
Michael G. Simpson
Kevin Thiele
Karen Wilson

CONSERVATION CODES
for Western Australian Flora and Fauna

T: **Threatened species** – Listed as Specially Protected under the *Wildlife Conservation Act 1950*, published under Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).

- Fauna that is rare or likely to become extinct are declared to be fauna that is in need of special protection
- Flora that are extant and considered likely to become extinct, or rare and therefore in need of special protection, are declared to be rare flora

Species* which have been adequately searched for and are deemed to be, in the wild, either rare, at risk of extinction, or otherwise in need of special protection, and have been gazetted as such.

The assessment of the conservation status of these species is based on their national extent.

X: **Presumed extinct species** – Listed as Specially Protected under the *Wildlife Conservation Act 1950*, published under Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora (which may also be referred to as Declared Rare Flora).

Species* which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.

IA: **Migratory birds protected under an international agreement** – Listed as Specially Protected under the *Wildlife Conservation Act 1950*, listed under Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice.

Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), relating to the protection of migratory birds.

S: **Other specially protected fauna** – Listed as Specially Protected under the *Wildlife Conservation Act 1950*. Fauna declared to be in need of special protection, otherwise than for the reasons mentioned for Schedules 1, 2 or 3, are published under Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice.

Threatened Fauna and Flora are ranked according to their level of threat using IUCN Red List categories and criteria. For example: Carnaby's Cockatoo (*Calyptorynchus latirostris*) is listed as 'Specially Protected' under the *Wildlife Conservation Act 1950*, published under Schedule 1, and referred to as a 'Threatened' species with a ranking of 'Endangered'.

Ranking:

CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild.

EN: Endangered – considered to be facing a very high risk of extinction in the wild.

VU: Vulnerable – considered to be facing a high risk of extinction in the wild.

A list of the current rankings can be downloaded from the Parks and Wildlife Threatened Species and Communities webpage at http://dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/

*Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies, variety or forma).

P: **Priority species** – Species that may be threatened or near threatened but are data deficient, have not yet been adequately surveyed to be listed under the Schedules of the Wildlife Conservation (Specially Protected Fauna) Notice or the Wildlife Conservation (Rare Flora) Notice, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Conservation dependent species that are subject to a specific conservation program are placed in Priority 5.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1: **Priority One: Poorly-known species**

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2: **Priority Two: Poorly-known species**

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3: **Priority Three: Poorly-known species**

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4: **Priority Four: Rare, Near Threatened and other species in need of monitoring**

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

5: **Priority Five: Conservation Dependent species**

Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

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